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AN ANALYSIS OF PURCHASE CARD RECONCILIATION TIMES

by

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ABSTRACT *(maximum 200 words)* Effective 1 October 1997, the Government Commercial Purchase Card was mandated for micro-purchases of commercial items (procurement valued at or below $2,500). As of August 1999, 97% of Navy activities use purchase cards for micro-purchases. During fiscal year 1998, these activities used the purchase card in over 1,996,000 transactions valued at $1.055 billion dollars. Overall, purchase card implementation has been an overwhelming success, drastically reducing administrative costs and providing a streamlined procurement process. Even though efforts have been made to refine the reconciliation process to help government activities avoid unnecessary interest payments, there are still many potential improvements. The government purchase card is similar to standard issue credit cards, so interest accrues on delinquent invoices. During the fourth quarter of fiscal year 1999, the U.S. Navy paid $323,000 in interest payments due to delinquent invoices. Of this total, the activities under CINCLANTFLT were responsible for $58,000 and those under CINCPACFLT were responsible for $43,000. A combination of data analysis and systems analysis techniques are used to define the reconciliation process, to suggest process improvements, and to recommend tools to better manage the reconciliation process.

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AN ANALYSIS OF PURCHASE CARD RECONCILIATION TIMES

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ABSTRACT

Effective 1 October 1997, the Government Commercial Purchase Card was mandated for micro-purchases of commercial items (procurement valued at or below $2,500). As of August 1999, 97% of Navy activities use purchase cards for micro-purchases. During fiscal year 1998, these activities used the purchase card in over 1,996,000 transactions valued at $1.055 billion dollars. Overall, purchase card implementation has been an overwhelming success, drastically reducing administrative costs and providing a streamlined procurement process. Even though efforts have been made to refine the reconciliation process to help government activities avoid unnecessary interest payments, there are still many potential improvements. The government purchase card is similar to standard issue credit cards, so interest accrues on delinquent invoices. During the fourth quarter of fiscal year 1999, the U.S. Navy paid $323,000 in interest payments due to delinquent invoices. Of this total, the activities under CINCLANTFLT were responsible for $58,000 and those under CINCPACFLT were responsible for $43,000. A combination of data analysis and systems analysis techniques are used to define the reconciliation process, to suggest process improvements, and to recommend tools to better manage the reconciliation process.

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LIST OF ACRONYMS

A list of definitions is provided in Appendix A.

AO – Approving Official

CINCLANTFLT – Commander in Chief, U.S. Atlantic Fleet

CINCPACFLT – Commander in Chief, U.S. Pacific Fleet

CNSL – Commander, Naval Surface Forces, U.S. Atlantic Fleet

CNSP – Commander, Naval Surface Forces, U.S. Pacific Fleet

DFAS – Defense Accounting and Finance Service

DoD – Department of Defense

EFT – Electronic Funds Transfer

FASA – Federal Acquisition Streamlining Act

FY – Fiscal year

IMPAC – International Merchant Authorization Card

NAVSUP – Naval Supply Systems Command

NPR – National Partnership for Reinventing Government

OPLOC – Operating Location, a paying activity under DFAS

OSD – Office of the Secretary of Defense

RMNB – Rocky Mountain National Bank

SALTS - Standard Automated Logistics Toolset

SPC – Statistical Process Control

TQM – Total Quality Management

UIC – Unit Identification Code

EXECUTIVE SUMMARY

Effective 1 October 1997, the Government Commercial Purchase Card was mandated for micro-purchases of commercial items (procurement valued at or below $2,500). As of August 1999, 97% of Navy activities use purchase cards for micro-purchases. During fiscal year 1998, these activities used the purchase card for over 1,996,000 transactions valued at $1.055 billion dollars. Overall, purchase card implementation has been an overwhelming success, drastically reducing administrative costs and providing a streamlined procurement process. Even though efforts have been made to refine the reconciliation process to help government activities avoid unnecessary interest payments, there are still many improvements. The government purchase card is similar to standard issue credit cards, so interest accrues on delinquent invoices. During the fourth quarter of fiscal year 1999, the U.S. Navy paid $323,000 in interest payments due to delinquent invoices. Of this total, the activities under CINCLANTFLT were responsible for $58,000 and those under CINCPACFLT were responsible for $43,000. As a result, this thesis focuses on units under Commander, Naval Surface Forces, U.S Atlantic Fleet (CNSL) and Commander Naval Surface Forces, U.S. Pacific Fleet (CNSP), two of the principle contributors to this interest accrual.

Based on analysis of CNSL and CNSP data, the shipboard reconciliation phase is the least stable and the one that is having the greatest impact on the invoice reconciliation process. In general, this phase has the greatest mean duration and variation. Program managers should concentrate on improving process stability in this phase of the process, but not at the expense of not analyzing other phases of the process. All phases contribute to the process duration, and an improvement in any phase will result in less interest accruing. Other phases of the process have high mean duration, but usually exhibit less variability. This research identifies three areas in which further training might assist some ships: understanding rolling balance; understanding the "pay and confirm" policy; and recognizing the importance of date stamping invoices.

Data analysis techniques also reveal a ship's operational reputation is significant. Fleet area experts can accurately assess a ship's overall operational reputation, but bias can influence this assessment. In this thesis, we recommend Statistical Process Control (SPC) tools to avoid personal bias by utilizing time series analysis to increase objectivity

in categorizing their units. SPC permits managers to avoid a bias resulting from one or two good (or bad) months' performance when categorizing ships. Several examples of how to use SPC and its benefits are given based on the CNSL and CNSP data analyzed.

One primary research goal of this thesis is to determine what the difference is between CNSL and CNSP. The significant difference between CNSL and CNSP is not within the higher ranked ships, but across the lower ranked ships. The CNSL higher ranked ships' process times are similar to those in CNSP, but the lower ranked CNSL ships have significantly worse process times than CNSP ships. The challenge for CNSL is to focus on the lower ranked ships to achieve parity with CNSP ships.

Systems analysis and data analysis techniques reveal that the bank shifts and policy changes significantly reduce the time that it takes ships to reconcile invoices. Overall, the mean reconciliation process time for all ships decreases over the period analyzed. Flow charts reveal potential improvements that are already being tested and implemented. Improvements like SALTS transmission and certification have the potential to further reduce the time that this process takes.

This research provides insight into the process of reconciling purchase card invoices even though it only focuses on two specific fleets. SPC can be utilized by any purchase card manager to monitor their units' reconciliation process. These findings apply specifically to CNSL and CNSP, but probably represent similar problems at other activities.

I. INTRODUCTION

This research evaluates the Department of the Navy purchase card program at the fleet level. It also recommends tools to manage this process more efficiently on both the program and fleet levels.

The government purchase card is referred to by many names: International Merchant Purchase Authorization Card (IMPAC), government VISA card, or government purchase card. Currently, it is referred to as a purchase card, since it is no longer a VISA card and IMPAC is the trade name of a past bank holding the purchase card contract.

The purchase card provides a more efficient and less costly method to purchase goods and services, since government activities can purchase directly from vendors instead of going through contracting specialists. The U.S. Army estimates that the Department of Defense (DoD) saves approximately $92.09 and 4.28 man-hours per transaction using the purchase card rather than traditional methods for procuring materials and services. [Ref. 1] Purchases below $100,000 account for over 98% of government purchases, and over 80% are below $2,500, so the potential cost savings is enormous. [Ref. 1] Currently, purchase cards are used only for purchases below $2,500 at the fleet level, although there have been discussions concerning raising this threshold. As a result, the government purchase card has quickly become the primary method for procuring small purchase requirements. Effective October 1987, purchase card use was mandated for all material and services procurements below $2,500. [Ref. 2] Any activity that does not want to use the purchase card must submit a waiver request for Naval Supply Systems Command (NAVSUP) approval.

Although the purchase card has the potential to save DoD money and time, there are problematic time lags in reconciling monthly invoices. These invoices summarize all charges to the purchase card during the previous month, similar to the monthly credit card bills for personal credit cards. The U.S. Navy paid $323,000 in interest payments due to delinquent invoices during fourth quarter fiscal year (FY) 1999. [Ref. 3] Of this total, the activities under the Commander in Chief, U.S. Atlantic Fleet (CINCLANTFLT) were responsible for $58,000 and those under the Commander in Chief, U.S. Pacific Fleet

(CINCPACFLT) were responsible for $42,000. [Ref. 3] The estimated cost savings are impacted by these interest payments, and much effort is being expended at policy levels to reduce interest payments.

This thesis evaluates the Department of the Navy purchase card program at the fleet level. Specifically, it focuses on identifying areas where there appear to be more problematic time lags in processing receiving monthly invoices.

A. BACKGROUND OF THE PURCHASE CARD

1. History prior to the purchase card

In the past, procuring materials or services classified as micro-purchases was a cumbersome, time consuming process if one did not want a stock numbered item. It required providing a detailed list of specifications and having a government procurement office determine the best source from which to obtain the material. This took much of the control out of the requiring activity's hands, and often resulted in over-specifying material to ensure that the activity would receive what they wanted. Additionally, it often took from several days to weeks for the activity to receive the material. Another procurement option is to set up a blanket purchase agreement, but this requires prior knowledge of items that might be needed and does not work well for emergency or short lead time items. If an activity wants a commercial item quickly, they can expedite the procurement process (at the expense of many man-hours) or utilize the imprest fund. The imprest fund is a small petty cash fund maintained by the activity for emergency purchases that is limited to small dollar transactions and has a very cumbersome and complex set of controls.

Recognizing these acquisition process limitations, the government first investigated using purchase cards as an alternate procurement method in the early 1980's. [Ref. 4] The purpose was not necessarily to speed up logistics times, but primarily to cut the costs of buying goods and services. The purchase card provided a less costly and more efficient way to buy goods directly from the vendor instead of through government

procurement offices. The problem was the statutory restrictions mandated for micro-purchases. These limited purchase card usage primarily to procurement offices.

In 1994, Congress enacted the Federal Acquisition Streamlining Act (FASA), with the President issuing Executive Order 12931. This order reduced and eliminated most of the restrictions over purchasing services and materials under $2,500, while relaxing restrictions for procurements under $100,000. For example: micro-purchases were no longer required to adhere to the Buy American Act and the requirements for military specifications were no longer as stringent. Since 1993, over 5,104 military specifications have been replaced by commercial descriptions and over 522 commercial item descriptions have been developed. [Ref. 1] FASA also removed many requirements concerning purchasing from small businesses as well as the general requirement for competition (now it is sufficient that the procurement official determine that the price is "fair and reasonable"). This act reduced many of the previous restrictions on micro-purchases and permitted real acquisition reform to begin.

2. Introduction of the purchase card

In 1994, Vice President Gore's National Performance Review identified purchase cards as a major acquisition reform and recommended all agencies increase their usage. In December 1994 and July 1995, interim rules were issued for the Federal Acquisition Regulations that cited purchase cards as the preferred method for micro-purchases and as an accepted method to make payments over the small purchase threshold. In March 1996, the use of imprest funds was eliminated with a few exceptions, such as contingency operations, which require approval by the Office of the Under Secretary of Defense for Acquisition and Technology. [Ref. 5] In October 1997, it became mandatory to use purchase cards for micro-purchases.

To ensure that there would be inter-service compatibility and to maintain some control of each service's programs, the Office of the Secretary of Defense (OSD) published a memorandum stating that DoD components should not devote resources to developing new purchase card systems. They should implement one of the existing systems selected in conjunction with the Defense Accounting and Financial Service (DFAS) and the Deputy Director for Information Management. [Ref. 6] Additionally, the

Under Secretary of Defense for Acquisition and Technology established a joint team to make recommendations on use of purchase cards as well as future applications.

In 1994, the purchase card accounted for 16% of DoD micro-purchases. By 1995, this number had more than doubled, and by 1996 procurement utilizing the purchase card accounted for approximately 52% of micro-purchases. [Ref. 4] Unfortunately, the purchase card was primarily used at procurement offices. Few ships had cards for their own use. The OSD's National Performance Goal for 1998 was to procure 80% of micro-purchases using the purchase card. The OSD goal for FY 2000 is 90%. [Ref. 7] Each service has been tracking their performance relative to this goal. Figure 1 depicts purchase card growth for the Department of the Navy. Since being mandated in October 1997, all services report that over 90% of FY 1998 micro-purchases were procured using the purchase card. The Department of the Navy goal for FY 1999 is 94%, and they had achieved 97% by the end of August 1999 (Figure 1). This increase is reflected in the dramatic increase in the number of cardholders, from less than 5,000 to over 31,000 since 1994 (Figure 2). This increase in cardholders resulted in a corresponding increase in the number of transactions from under 300 thousand to about 2 million (Figure 3); purchase card sales increased from 100 million dollars to over 1 billion dollars in the same time frame (Figure 4).

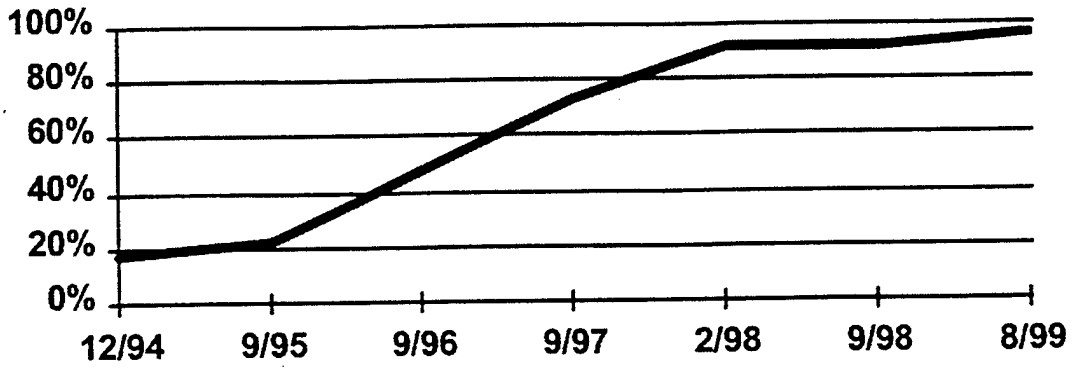


Figure 1 Percent of U.S. Navy micro-purchases made with the purchase card from December 1994 through August 1999. [Ref. 8]

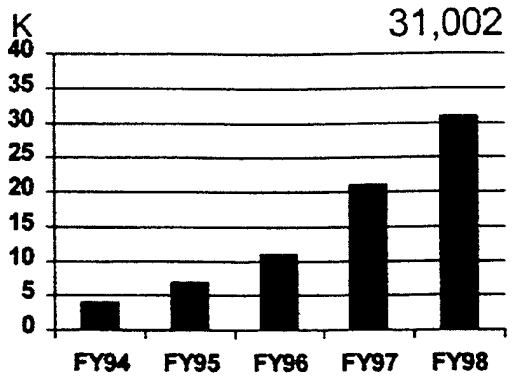


Figure 2 Number of U.S. Navy cardholders from FY 1994 through 1998. It is estimated that the number of cardholders at the end of FY 1999 will be 35,760. [Ref. 8]

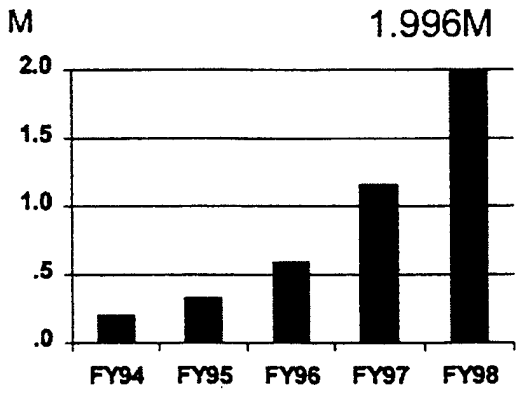


Figure 3 Number of transactions using the purchase card from FY 1994 through 1998. It is estimated that the number of transactions for FY 1999 will be 2.098 million. [Ref. 8]

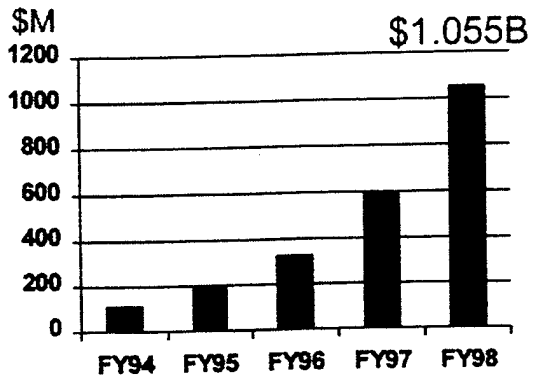


Figure 4 Amount of sales using the purchase card from FY 1994 through 1998. It is estimated that the amount of sales for FY 1999 will be $1.213 billion dollars. [Ref. 8]

3. Benefits of Using the Purchase Card

The purchase card permits activities to commercially procure, from a local source, material and services costing below $2,500. Billing is forwarded monthly and reconciled for payment. This drastically reduces both the ordering and shipping time and the logistics system's responsiveness.

The U.S. Army estimates the savings per purchase card transaction as follows:

- The average cost for a regular purchase order is $131.62 and requires 6.28 man-hours. [Ref. 1]
- The average cost for a small purchase using the purchase card is $39.03 and requires 2.00 man-hours. This assumes no interest paid on the invoice. [Ref. 1]
- The total savings are $92.09 and 4.28 man-hours. [Ref. 1]

The March 1997 OSD memo discusses the fact that purchase cards also save an undetermined amount of the requiring activity's time by permitting order placement using fax, on line, by phone, or in person. It also saves money at the paying activity level by making one monthly payment rather than individual payments for each transaction.

B. PROBLEMS ENCOUNTERED

All services are experiencing problems regarding delinquencies and interest paid, vendor acceptance, intra-service transactions, and purchases above the micro-purchase threshold. Each service appears to be addressing the delinquency concern separately by implementing electronic interfaces to streamline the billing and reconciliation process; looking at design flaws within the system that create delays in processing; and analyzing the reconciliation process. Another significant problem being addressed is the redundancies and multiple levels of authority within the procurement process. For example, one cause of invoice delinquencies within the Navy appears to be discrepancies between designated paying offices and activities. As a result, Stars One Pay System helps reduce delinquent bills by creating an electronic interface to enhance information sharing. DoD wide, the Purchase Card Financial Management Team and Purchase Card Integrated Product Team of the Under Secretary of Defense for Acquisition and Technology are promoting and facilitating streamlined procedures for procurements between $2,500 and $25,000.

The purchase card program manager for the Department of the Navy is NAVSUP Code 21. They are responsible for recommending purchase card management systems and developing future policies and standards for all Navy and Marine Corps activities. NAVSUP Code 21 is particularly interested in investigating ships under Commander, Naval Surface Forces, U.S. Atlantic Fleet (CNSL) and those under Commander, Naval Surface Forces, U.S. Pacific Fleet (CNSP). Both fleets have a large number of activities using the card, and they appear to be two of the principal contributors to interest payments at the CINCLANTFLT and CINCPACFLT level. Additionally, there appears to be differences in performance across the two fleets, even though their directives are the same.

NAVSUP Code 21 attempts to categorize why the invoice was delayed. Delays due to activity errors or DFAS operating locations (OPLOC) errors are tracked to identify problems reconciling invoices for payment. Some errors cannot be tracked (like mail delays), and are categorized as "other errors." Table 1 displays the interest paid by the Navy when invoice reconciliation takes more than 30 days from activity receipt.

Table 2 breaks these numbers down to display the percent of interest paid due to activity, OPLOC, and other errors. The percentages in Table 2 support the findings in Chapter III: the ship's invoice reconciliation time is the least stable phase in the invoice reconciliation process and appears to cause many of the problems. Table 2 confirms the fact that most of the interest charges appear to result from activity errors. Detailed numbers for the interest paid due to activity errors categorized by major claimant and OPLOC errors for fourth quarter of FY 1999 are provided in Appendix B.

CINCLANTFLT and CINCPACFLT are two of the major contributors to interest payments. Activity errors in these two fleets account for over $99,000 of the interest paid during the fourth quarter of FY 1999 (Appendix B). This is why the sponsor wanted to focus research on CNSL and CNSP, which comprise a large part of CINCLANTFLT and CINCPACFLT purchase card transactions.

Month	Activity Errors	OPLOC Errors	Other Errors
June	$84,657.19	$9,373.19	$10,371.67
July	$69,859.46	$17,780.16	$9,007.08
August	$100,327.75	$5,431.53	$15,888.80
Interest Paid	$254,844.40	$32,584.88	$35,267.55

Table 1 Interest paid fourth quarter FY 1999 due to delinquent invoices. Total interest paid fourth quarter FY 1999 was $322,696.83. [Ref. 3]

	June	% Interest Paid	July	% Interest Paid	August	% Interest Paid
Activity Errors	$84,657.19	81.09%	$69,859.46	72.28%	$100,327.75	82.47%
OPLOC Errors	$9,373.19	8.98%	$17,780.16	18.40%	$5,431.53	4.46%
Other Errors	$10,371.67	9.93%	$9,007.08	9.32%	$15,888.80	13.06%

Table 2 Percent interest paid fourth quarter FY 1999 due to identified errors in reconciling invoices. [Ref. 3]

The goal of all services is to make purchasing materials below these thresholds as efficient as possible. The above tables merely illustrate the scope of the problem facing NAVSUP Code 21 in controlling the reconciliation process time.

C. RESEARCH GOALS

This research specifically focuses on interest payments and the reconciliation process. Interest paid and the time that activities take to reconcile invoices are a large concern on the program manger's level.

1. Primary Research Questions

a. What is the primary cause of time delays in reconciling invoices for charges incurred on government purchase cards? Where should NAVSUP Code 21 concentrate their efforts in controlling this process?

b. Is there a difference between the ships under CNSL and those under CNSP? If so, what is the difference?

2. Secondary Research Questions

a. How can NAVSUP Code 21 best manage this process and what management tools are available? What tools can they give their subordinate activities to manage this process?

b. What improvements can be made to the invoice reconciliation process?

D. OVERVIEW OF THE THESIS

To answer these questions, several approaches are used. First, purchase card invoices for selected ships from both CNSL and CNSP are analyzed. These records are extracted from the DFAS database. Chapter II describes the methods used to collect the data, errors discovered in the database, and assumptions made in computing summary statistics. Chapter III discusses the results of the data analysis. It is also vital to unravel and understand purchase card reconciliation procedures, thus we also use a systems approach to develop flow charts of the purchase card reconciliation process. This approach is based on in-depth interviews with area experts: Ms. Marie Taramelli (NAVSUP Code 21), Mr. Dave Gagnon (DFAS), Commander Chris Valle (CNSL Code 041), Mr. Jack Newcomer (CNSL Code 041), and Lieutenant Kristen Fabry (CNSP Code 041). These results are contained in Chapter IV. In addition, Chapter IV uses statistical process control (SPC) to monitor these processes. Finally, Chapter V provides

recommendations and conclusions based on the analyses presented in Chapters III and IV.

II. DESCRIPTION OF THE DATA

This chapter discusses the data collection methods and database errors discovered. This data forms the basis of the analysis in Chapter III and is used to illustrate SPC tools in Chapter IV.

A. SAMPLE SELECTION

For all samples, ships are selected by fleet area experts. Initial data is analyzed for three ships selected with respect to size of the supply operation (volume of purchase card business), and "quality of the supply operation." The "quality" of the supply operation is a subjective assessment based on input from Commander Chris Valle, the CNSL Purchase Card Program Coordinator. Three ships are selected based on their operational reputations: one excellent, one average, and one poor. These selections represent Commander Valle's perceptions of the ship's operations and their inspection results. This selection precludes any bias due to quality of supply operation or volume of business. Data analysis and systems analysis is conducted on this initial sample to determine initial findings and recommendations. Management tools are then applied to this initial sample to determine which tools are the most useful.

Next, 15 ships are selected from CNSL using the same criterion as above. Five ships are selected from each category. The initial findings are tested on this sample, and then management tools are applied.

Finally, 15 ships are selected from CNSP with five ships selected from each category. Data analysis and systems analysis is conducted on this sample, and findings are compared to those from the CNSL ships.

B. TIME FRAME

The time frame for the data is January 1998 until June 1999. Purchase card use was mandated as of October 1997, and most ships obtained cards by the end of the first quarter of FY 1998. DFAS pays on an invoice level, thus data is only available on a monthly basis, not on a transaction basis. As a result, transaction type is not used in this analysis.

Since October 1987, two different banks have managed the contract for purchase cards. Initially, Rocky Mountain National Bank (RMNB) was awarded the contract. Effective July 1998, this responsibility shifted to U.S. Bank, a subsidiary of RMNB. Accompanying this shift in responsibility was a major shift in policy. Instead of certifying the transaction for payment only after material receipt, the new policy, "pay and confirm," permits certification for payment before receipt. Additionally, U.S. Bank gave ships the option of transmitting the certified invoice to the paying activity via naval message vice hard copy.

Effective January 1999, Citibank was awarded the contract for purchase cards. Citibank's stated goal was to automate the reconciliation process to permit faster invoice payment. Presently, once a ship receives a monthly statement, it has 15 days to reconcile it and forward it to DFAS for processing. Over the past months, they have been making progress toward this goal, under the CitiDirect Program and the NAVSUP authorized SALTS program modifications. As a result, the time period from January 1998 until June 1999 is divided into three time frames, reflecting these policy and bank contract changes.

C. VARIABLE SELECTION

Many fields of information can be extracted from the DFAS database. Table 3 lists the information extracted by executing a query based on the selected ship's Unit Identification Code (UIC) and the phases of the purchase card process.

Data extracted	Definition of data field extracted
Invoice number	A 12-digit number assigned to each invoice generated by the issuing bank Invoice numbers beginning with "17" are assigned by RMNB Invoice numbers beginning "30" are assigned by U.S. Bank Invoice numbers beginning with "77" are assigned by Citibank
Certifying UIC	The responsible ship's 5-digit unit identification code
Invoice date (InvDate)	The date the invoice is generated by the issuing bank
Account received date (ActRecDt)	The date the ship annotates on the invoice indicating receipt onboard If the invoice is not date stamped, this date defaults to the invoice date
OPLOC received date (OPLOCRecDt)	The date the certified invoice is received at the paying activity
Pay date (PayDate)	The date the paying activity pays the invoice
Amount paid	The total amount charged to the purchase card during the previous month
Interest paid	Self assessed interest paid to the bank for invoices paid 30 days or more after the account received date. Interest below $1.00 is not paid.
EFT #	The electronic funds transfer number All invoices are paid to the bank electronically

Table 3 Information extracted from the DFAS database.

All files are received in Microsoft Excel format for review, and transferred to S-PLUS version 4.5 and Minitab version 12 for analysis. Table 4 lists the variables selected for analysis. The time-measured variables (InvPay, InvActRec, ActRecOPLOCRec, and OPLOCRecPay) are selected to measure the significant phases of the purchase card process.

Variable	Definition of variable
InvCat	Invoice Category 1 denotes RMNB invoices Invoice Category 2 denotes U.S. Bank invoices Invoice Category 3 denotes Citibank invoices
Rank	Rank 1 denotes the ships with the best operations Rank 2 denotes the ships with mediocre operations Rank 3 denotes the ships with the poorest operations In the initial sample, UIC Cat equals Rank due to a sample size of three ships
InvPay	The total time (in days) from invoice date until pay date
InvActRec	The total time (in days) from invoice date until account received date
ActRecOPLOCRec	The total time (in days) from account received date until received at OPLOC
OPLOCRecPay	The total time (in days) from receipt at the paying activity until paid
IntAmt	Interest paid divided by amount of the invoice

Table 4 Variable Definition.

All data received from DFAS is reviewed to eliminate a specific error inherent to the database. Presently, once a ship receives a monthly statement, it has 15 days to reconcile it and forward it to the paying activity for processing. When a properly certified invoice is received at the paying activity, the entire invoice is usually paid within three working days. Otherwise, the entire invoice is suspended and nothing is paid until the discrepancy is resolved. If the invoice suspends and requires resubmission (i.e., it is not signed or does not have the correct line of accounting), this record of invoice submission remains on the database. When the ship resubmits the corrected invoice for payment, a new record is generated recording this submission. The paying activity will pay only one invoice, the correct one, but the previous submission remains on the database as unpaid. For CNSL units, this accounts for 39 deletions from a sample data set of 289 records. For CNSP units, this accounts for ten deletions from a sample data set of 268 records.

Because invoices are selected in the time frame from January 1998 to June 1999, some are still unpaid at the initial sampling. For the initial sample of three ships, all unpaid invoices are reconciled. For the two larger samples of 15 CNSL and CNSP ships, this is not possible. The date that the sample is generated is selected as the cut off date. Thus, the point estimates in Appendix C represent a lower bound on the number of days required for each phase of the process. In the samples taken, 15 records out of 289 total records are right censored for CNSL activities and eight records out of 268 total records are right censored for CNSP activities.

D. INTEREST PAYMENTS

Interest calculations are extracted to determine if the interest due is being calculated correctly. In all sample data sets, there appears to be no errors in interest calculations. Interest is self-assessed by DFAS if invoices are not paid within 30 days of the account received date and the interest amount is more than one dollar. Interest continues to accrue until payment is made. The current interest rate is six percent.

III. DATA ANALYSIS

This study identifies which phases of the reconciliation process have the largest mean duration and the largest variance. We approach this primarily with exploratory and graphical data analysis followed by more formal techniques to confirm the findings. This will assist program managers in determining where to concentrate their efforts in controlling the process.

Looking at the variability in the duration of each phase reveals phases in the process that are not stable. Concentrating efforts on these phases reduces variability in the process, and it will become more stable. In other phases, the process is in control, i.e. variability in duration is low, but the mean duration of the phase is high. These phases also need attention to reduce the overall time required.

A. GRAPHICAL ANALYSIS

1. An Overall View of the Reconciliation Process

Figures 5 through 8 depict the relationship between different phases of the reconciliation process and the ship's rank (excellent, average, or poor). Each graph plots Rank versus the beginning date of each phase of the process. The initial sample of three ships is used to construct these plots, thus each row represents one ship. Similar results are found, but not reproduced here, for the 15 CNSL and 15 CNSP ships. The spacing of the columns indicates the flow of the process through each phase. Evenly spaced data points reflect a smooth, stable process. Large gaps in the data points develop when an invoice remains in any phase for an extended period of time. The larger the gap, the longer the delay in that phase of the process.

In Figures 5 through 8, the data points on the bottom row of each graph reflect the reconciliation process of the best ship (Rank 1). Notice that the spacing of the data points in this column shows a consistent, relatively smooth reconciliation process. There are

few gaps, indicating that most invoices remained at each phase of the process for approximately the same amount of time.

In Figures 5 through 8, the data points on the middle row of each graph reflect the reconciliation process of the average ship (Rank 2). As can be seen, by comparing Figure 5 to Figure 8, the spacing becomes less regular as the process progresses. This indicates that some invoices remain in some phases of the process longer than others. In this case, it can be seen that the ship did not certify their invoices for a two to three month period. This creates the large gap in the center area of the graph as the invoice progresses from Figure 6 to Figure 7. Other than this time period, the ship reconciles invoices fairly regularly. Most other Rank 2 ships also exhibit this behavior; they reconcile invoices fairly regularly, but at times have larger than usual delays in submitting certified invoices. Based on interviews with the CNSL area experts, it appears that the ship has some turnover of key personnel during this time period. The turnover of key personnel probably slowed the reconciliation process on the ship.

In Figures 5 through 8, the data points on the top row of each graph reflect the reconciliation process of the worst ship (Rank 3). Progressing from Figure 5 to Figure 8, the data points are very irregular throughout the entire time period. Most of the other Rank 3 ships exhibit this behavior; they are very erratic at reconciling invoices, at times having very large delays in submitting certified invoices. Based on interviews with the CNSL area experts, it appears that these problems again may be related to personnel turnover during this time period. During the eighteen months that this data represents, the ship had four different AOs. This may have affected the reconciliation process. Deployment schedules do not appear to delay the reconciliation process.

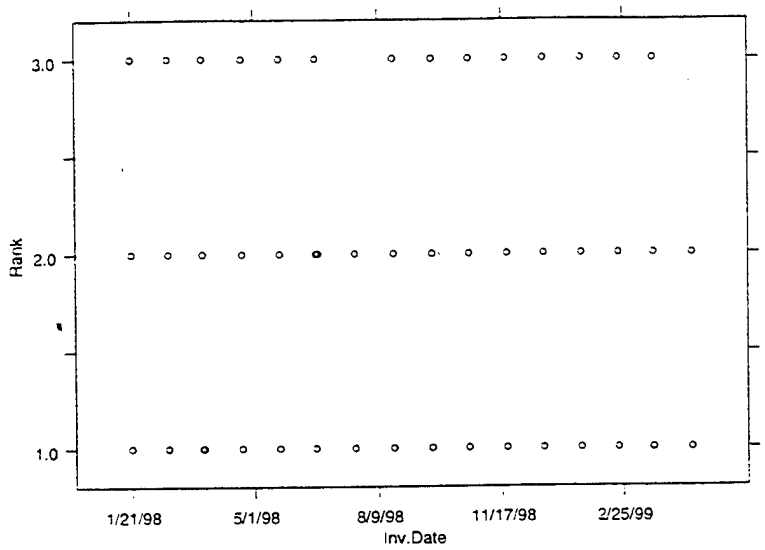


Figure 5 Ship Rank versus InvDate that each phase begins for the initial sample of three CNSL ships.

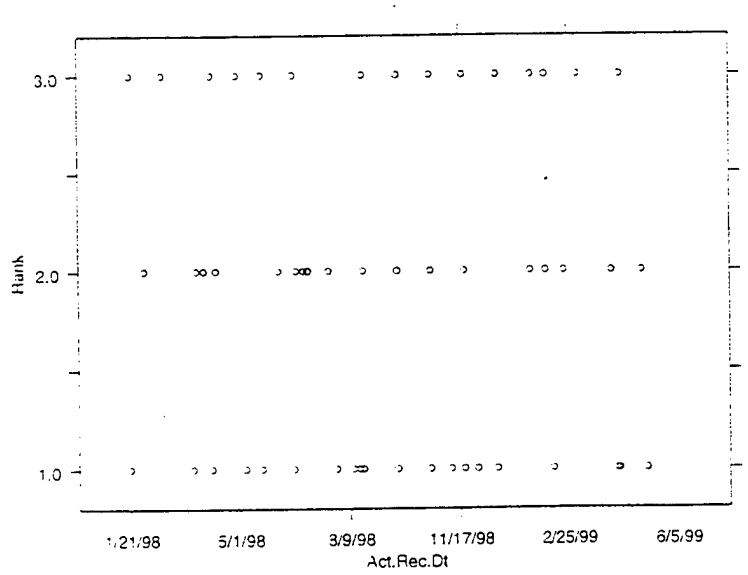


Figure 6 Ship Rank versus ActRecDt for the initial sample of three CNSL ships.

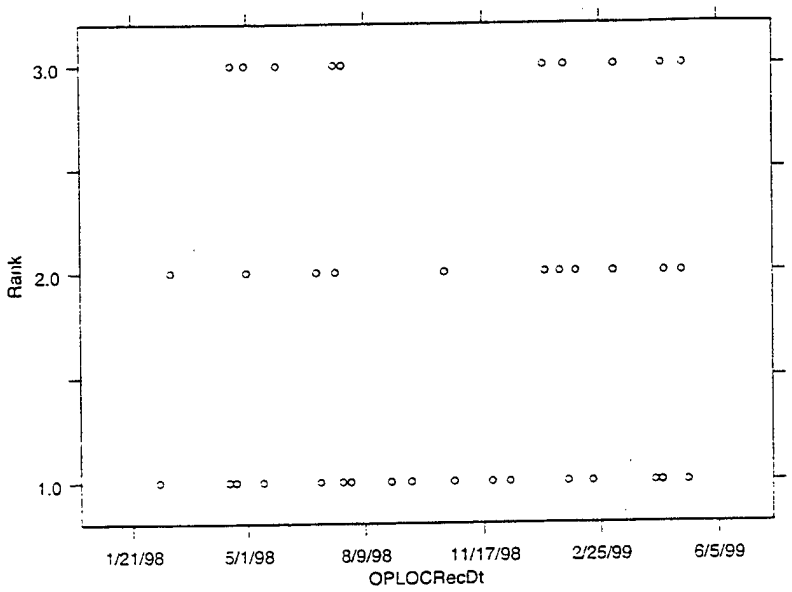


Figure 7 Ship Rank versus OPLOCRecDt for the initial sample of three CNSL ships.

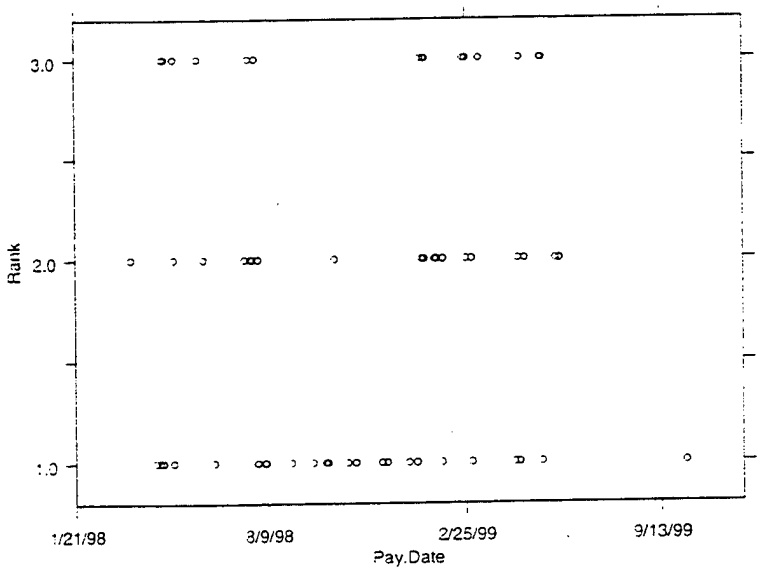


Figure 8 Ship Rank versus PayDate for the initial sample of three CNSL ships.

Figures 9 through 12 graphically depict the relationships between the different phases of the reconciliation process. Each figure depicts the beginning date of one of the phases and graphs the relationship between that phase and the beginning of the next phase. These same results are apparent in the samples of 15 ships drawn from CNSL and CNSP. Observe that the relationship between Inv Date and ActRec Date is almost linear (Figure 9), but the graphs depicting the relationship between Inv Date and the other phases have more points that are not linear (Figures 10, 11, and 12). The greatest deviation from linearity appears to be caused when the invoice is being reconciled on the ship (Figure 10). Notice also that the relationship between OPLOCRec Date and Pay Date is almost linear (Figure 12). This reflects the fact that most of the process variation occurs during the phase when the ship receives the invoice until when OPLOC receives the certified invoice (the variable ActRecOPLOCRec measures the duration of this phase of the process).

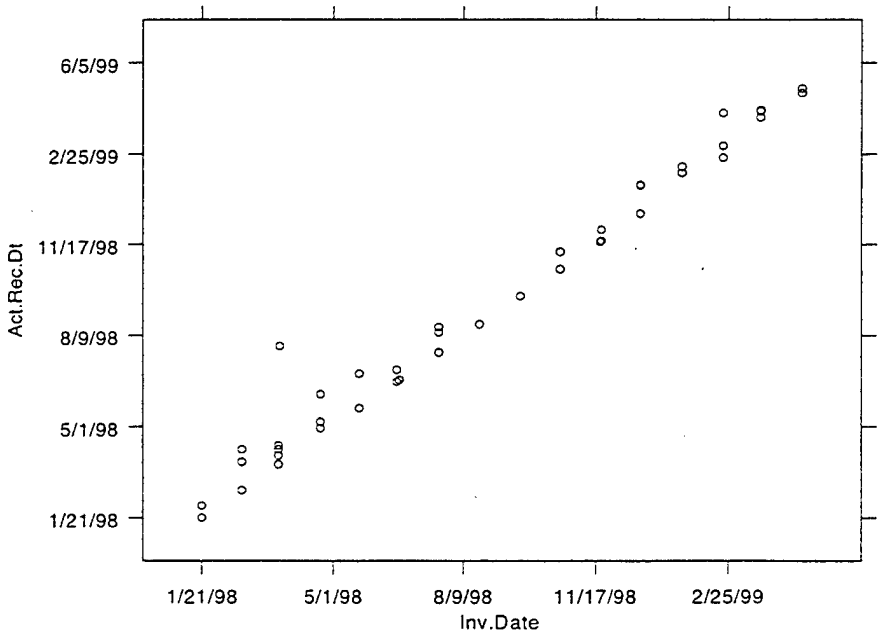


Figure 9 The relationship between invoice date and date received on the ship.

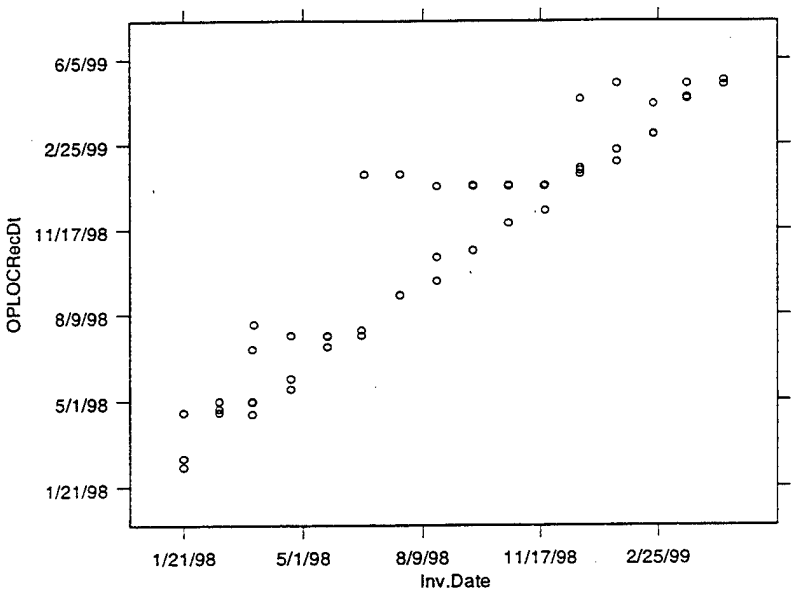


Figure 10 The relationship between invoice date and date received at OPLOC.

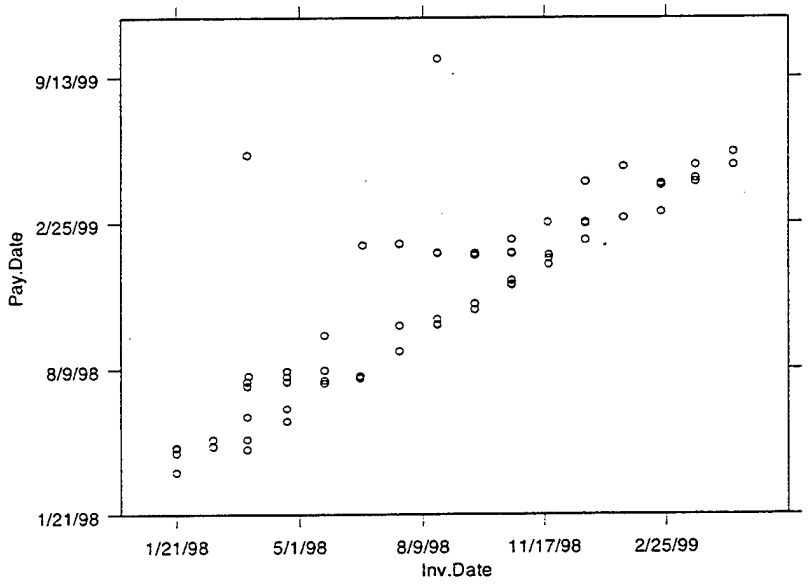


Figure 11 The relationship between invoice date and pay date.

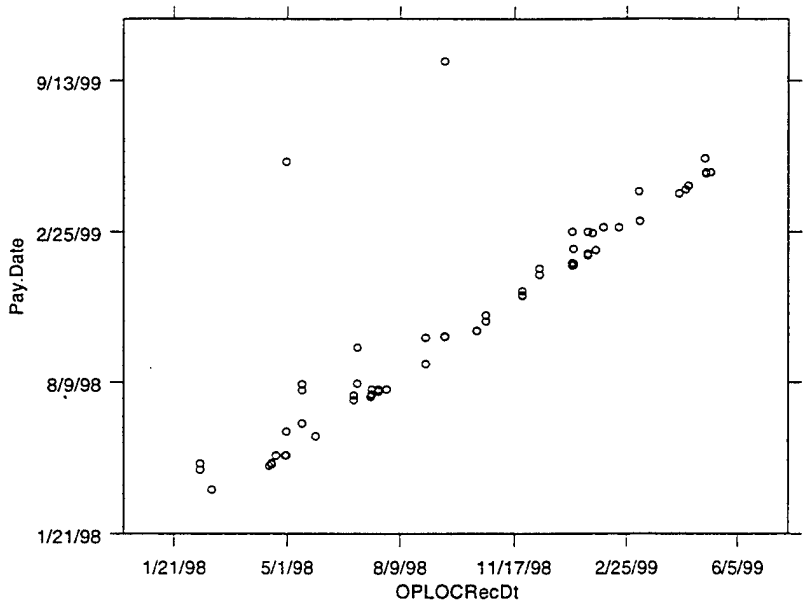


Figure 12 The relationship between date received at OPLOC and pay date

Figures 13 through 16 graphically depict the relationship between the ship rank, invoice category, interest paid (scaled by the amount of the invoice), and the length of the process. These same results are apparent in the initial sample drawn from CNSL. Figures 17 and 18 are provided because the sample from CNSP differs in the corresponding relationships.

When examining Figures 13 and 14, the data points in the left column reflect the reconciliation process during the time period that RMNB managed the purchase card contract (InvCat 1). The data points in the middle column reflect the reconciliation process during the time period that U.S. Bank managed the purchase card contract (InvCat 2). The data points in the right column reflect the reconciliation process during the time period that Citibank managed the purchase card contract (InvCat 3).

In Figures 13 and 14, both IntAmt and InvPay are the lowest for Citibank invoices and the highest for U.S. Bank invoices. Reconciliation times are expected to improve with the option of submitting certified invoices by naval message and the "pay and confirm" policy. After conducting interviews with the CNSL, DFAS, and NAVSUP Code 21 area experts, it appears that these problems may be related to the change in bank

billing policy. RMNB invoices show the monthly invoice balance as the balance due even if there are unpaid invoices from past months. U.S. Bank and Citibank use a rolling balance concept where the monthly charges are sub-totaled for the previous month, but the balance due includes past unpaid invoices. This is the same billing policy that is applied to personal credit card bills; the balance due reflects the amount due for current month charges plus any charges not paid from previous months. With the systems analysis, it is obvious which ships do not understand the concept of rolling balance and which do. These same findings are apparent in the CNSP ships sampled.

In Figures 15 and 16, the data points in the left column reflect the reconciliation process for the best ships (Rank 1). The data points in middle column reflect the reconciliation process for the average ships (Rank 2), and the data points in the right column reflect the reconciliation process for the worst ships (Rank 3). Notice that the Rank 1 ships have the shortest overall InvPay time and the smallest interest payments whereas the Rank 3 ships have the longest overall InvPay time and the highest interest payments (Figures 15 and 16). This difference is not as marked between the Rank 1 and 2 ships, but it is for the Rank 3 ships.

In comparison, CNSP Rank 2 ships appear to be worse than Rank 3 ships (Figures 17 and 18). This reflects one ship that is categorized incorrectly (it should be ranked in the third group). Furthermore, ships in CNSP are all much closer in their performance. Overall, most of the CNSP ships' reconciliation times are very close. The CNSP area expert indicates, on her selection sheet, that choosing ships in the three rankings is difficult because they are generally close in their performance.

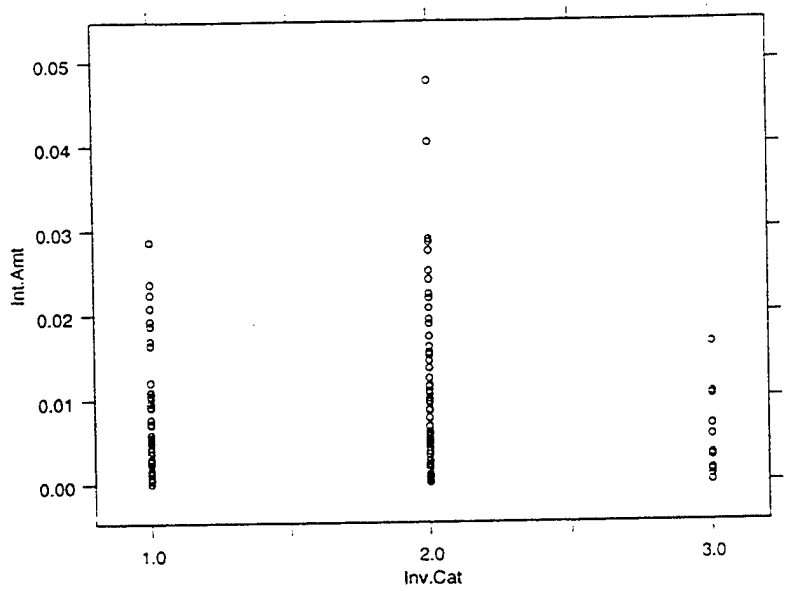


Figure 13 Interest paid scaled by amount of invoice versus Invoice Category for the sample of 15 CNSL ships.

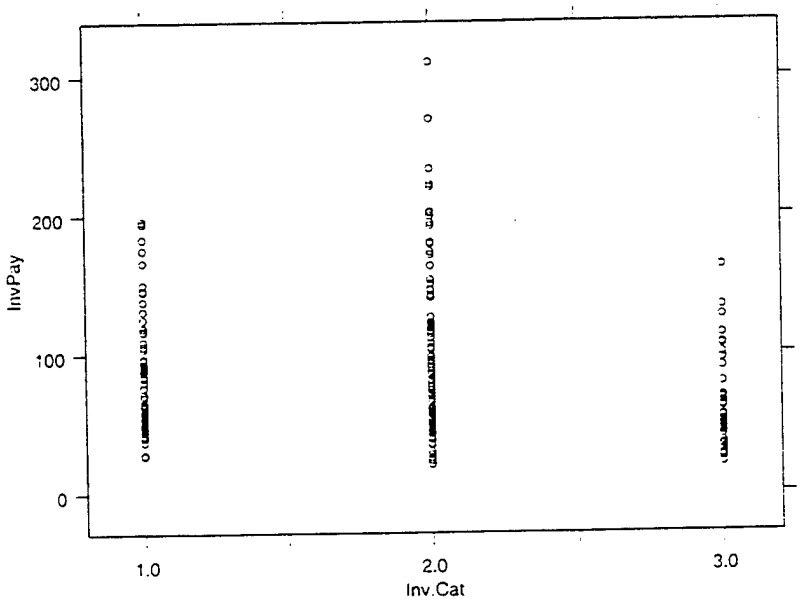


Figure 14 Total reconciliation time versus Invoice Category for the sample of 15 CNSL ships.

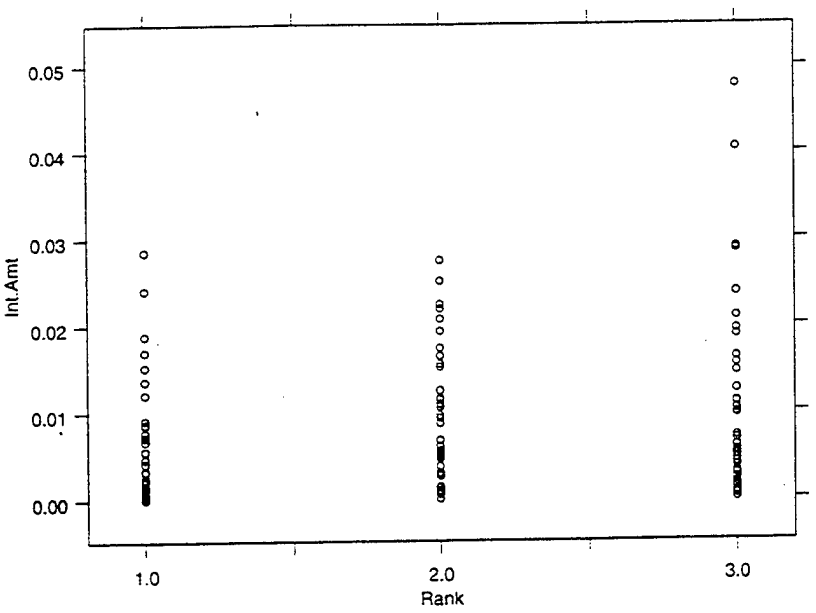


Figure 15 Interest paid scaled by amount of invoice versus Rank for the sample of 15 CNSL ships.

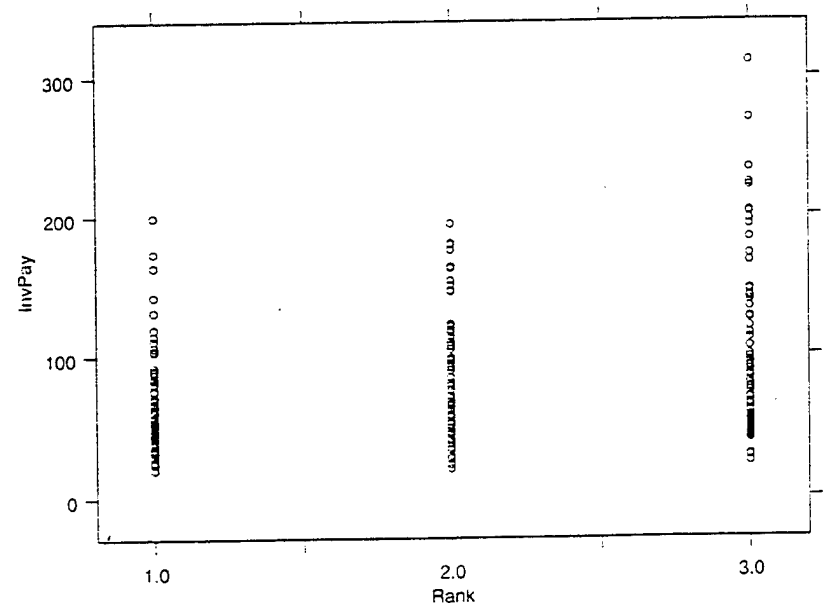


Figure 16 Total reconciliation time versus Rank for the sample of 15 CNSL ships.

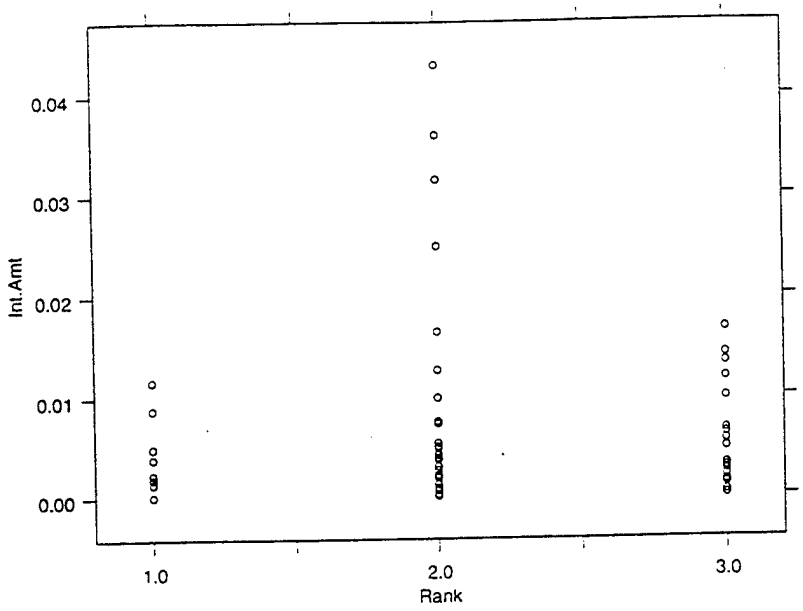


Figure 17 Interest paid scaled by amount of invoice versus Rank for the sample of 15 CNSP ships

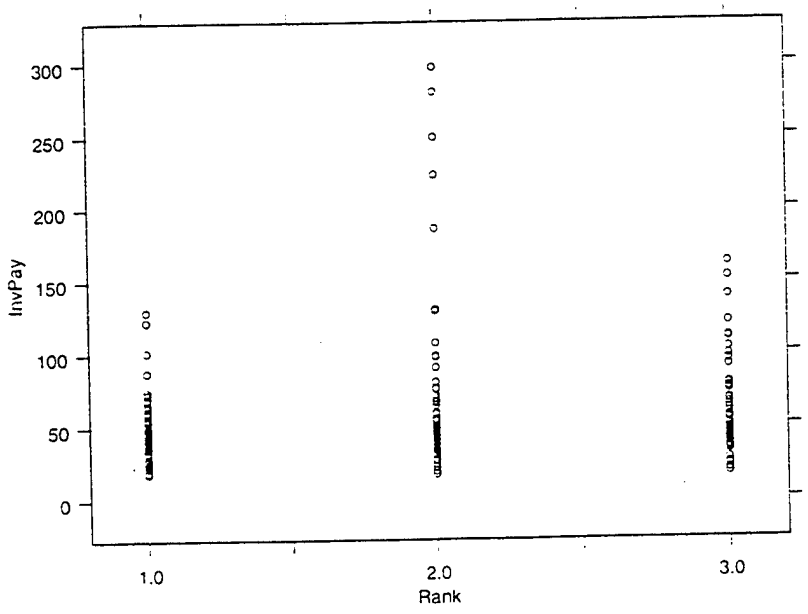


Figure 18 Total reconciliation time versus Rank for the sample of 15 CNSP ships

2. The Differences Between CNSP and CNSL

Figures 19, 20 and 21 use smoothing splines [Ref. 9] to graphically display the differences between CNSL and CNSP. Notice the spacing differences between the lines in Figures 19 and 20. The widest gap is between ActRecDate and OPLOCRecDate, but this gap is much more noticeable on the CNSL graph. This gap shows that the largest delay in reconciling invoices is the time that the ship holds the invoice. The time that the certified invoice is at the paying activity is significantly less.

Figures 19 and 20 display the differences between CNSL and CNSP on a macro level by depicting the relationship between the process start (InvDate) and the beginning dates for the other process phases for both fleets. Figure 21 displays this relationship on a more detailed level, by ship rank.

On the macro level, the difference between CNSL and CNSP appears to be in the ActRecOPLOCRec times and the total average time for the entire process. The spacing between the lines indicates the amount of time that invoices remained in that phase. For CNSL units, the longest phase appears to be ActRecOPLOCRec (Figure 19), but the lines are much more widely spaced than those in the CNSP samples (Figure 20). It should also be noted that the spacing between lines decreases over time for both fleets. This reflects the fact that both CNSP's and CNSL's reconciliation times have decreased over the sample's time frame.

Figure 21 confirms this fact, but also displays the differences between ship ranks in the two fleets. The graphs in the left column are CNSL ships; the graphs in the right column are CNSP ships. The Rank 1 ships are on the first row; the Rank 2 ships on the second row; and the Rank 3 ships are on the third row. There is a noticeable difference between CNSL ship ranks, but not between CNSP ship ranks. Furthermore, the CNSL Rank 1 graph is very similar to the CNSP graphs. The difference in the two fleets lies in the lower ranked ships. The better ships in CNSL are as good as those in CNSP, but the lower ranked ships in CNSL are significantly different from the rest of the fleet.

The problem remains, how can CNSL identify these lower ranked ships (other than by a subjective assessment)? Once identified, if their performance improves to the level of the other ships, the two fleets will be homogeneous. Overall, the subjective

assessments of the fleet area experts are accurate; only three ships are categorized incorrectly out of the 33 sampled.

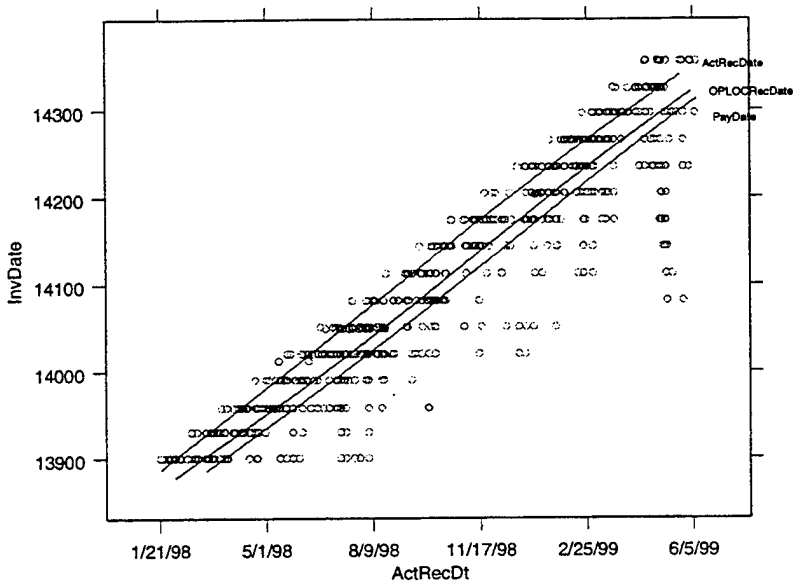


Figure 19 Smoothing spline for the sample of 15 CNSL ships.

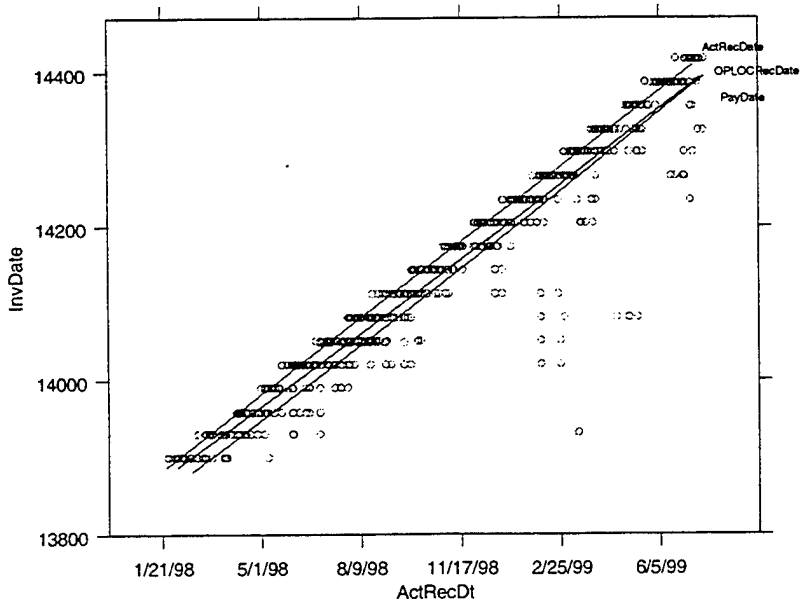


Figure 20 Smoothing spline for the sample of 15 CNSP ships.

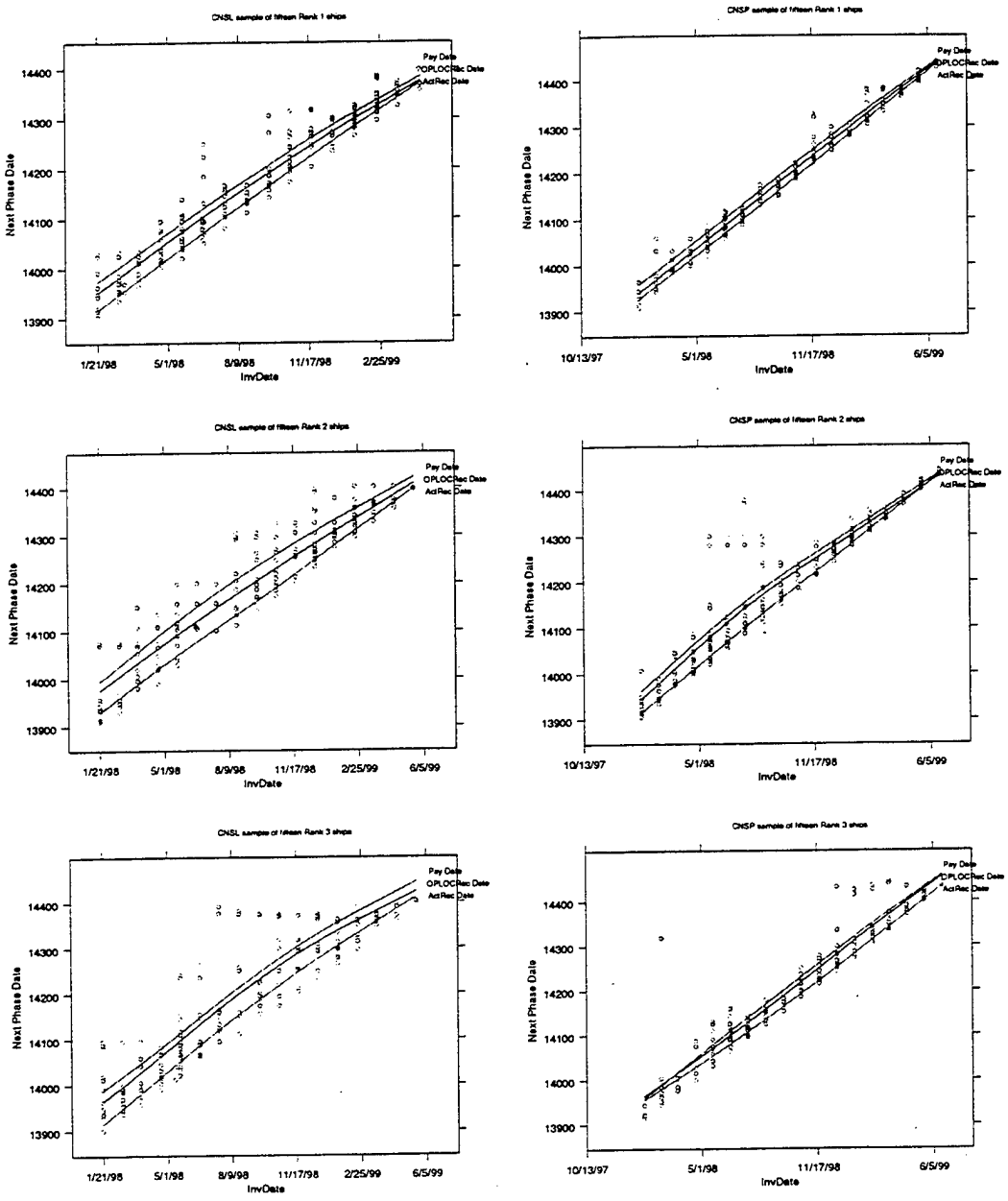


Figure 21 Smoothing spline for CNSL and CNSP ships by Rank.

B. STATISTICAL ANALYSIS

Estimates for the mean and standard errors are given in Appendix C. These support the findings contained in Figures 19 through 21. In particular, the primary difference between CNSL and CNSP is that the CNSL ships' reconciliation times vary more between ship ranks than do CNSP ships' reconciliation times. In addition, the variation within ship rank is much larger in the lower ranked CNSL ships. Management tools will be described in Chapter IV to help CNSL managers identify and manage lower ranked ships. Use of these recommended tools will assist the progress towards fleet parity.

Analysis of Variance Models (ANOVA) are fit with the response variables InvPay and IntAmt and dependent variables InvRecActRec, ActRecOPLOCRec, and OPLOCRecPay. All ANOVA models yield the same results for both responses: ActRecOPLOCRec is the most significant variable. Table 5 displays the F-values testing the partial effect of the dependent variables. In most cases, the F-values are as much as ten times higher for ActRecOPLOCRec than the F-values for the other variables. As shown in Table 6, ActRecOPLOCRec consistently has the lowest p-values no matter which response is used. The sample correlation is calculated for both response variables to determine the correlation between variables. As can be seen in Table 7, the sample correlation is highest and approaches one for the variable ActRecOPLOCRec.

F-Values	InvActRec	ActRecOPLOCRec	OPLOCRecPay
Response: IntAmt/InvPay			
Sample of three CNSL ships	9.0009 / .0600	204.2008 / 122.2761	1.4773 / 1.6095
Sample of fifteen CNSL ships	17.6692 / 40.5710	904.5897 / 224.985	46.6935 / 28.3078
Sample of fifteen CNSP ships	2.5882 / 65.5095	1310.634 / 455.7229	.09981 / 1.5424

Table 5 F-Values from ANOVA results for all samples.

P-Values	InvActRec	ActRecOPLOCRec	OPLOCRecPay
Response: IntAmt/InvPay			
Sample of three CNSL ships	.0038 / .807	0 / 1.11e-16	.2286 / .209
Sample of fifteen CNSL ships	3.626e-5 / 8.6e-10	0 / 0	5.98e-11 / 2.24e-7
Sample of fifteen CNSP ships	.092 / 2.19e-14	0 / 0	.752 / .215

Table 6 P-Values from ANOVA results for all samples.

Sample Correlations	InvActRec	ActRecOPLOCRec	OPLOCRecPay
Response: IntAmt/InvPay			
Sample of three CNSL ships	.3487 / .0304	.8709 / .8080	.1491 / .1554
Sample of fifteen CNSL ships	.2532 / .3686	.8821 / .6825	.4324 / .3144
Sample of fifteen CNSP ships	.1017 / .4451	.9140 / .7952	.0169 / .0761

Table 7 Sample correlation values for all samples.

C. SUMMARY

Data analysis is used to identify the shipboard reconciliation phase as the least stable and the one that is having the greatest impact on the invoice reconciliation process. In general, this phase has the greatest mean duration and variation. Program managers should concentrate on improving process stability in this phase of the process, but not at the expense of not analyzing other phases of the process. All phases contribute to the process duration, and an improvement in any phase will result in less interest accrual.

IV. SYSTEMS ANALYSIS

Whereas data analysis provides information about each phase's stability and mean duration, systems analysis provides insights into both how the process is working and possible tools to manage the process. Using flow charts, the process is defined and presented in an easily understood format. Descriptive statistics and control charts provide tools to help the manager monitor the process.

This chapter will first discuss the flow charts, then the systems analysis tools. Last, we will apply these tools to draw conclusions and recommendations about the reconciliation process.

A. BACKGROUND OF SPC

We employ techniques and methodologies primarily used by engineers and other technical professions to monitor and manage the reconciliation process. This philosophy of quality control and quality improvement has been embraced by industry and has greatly improved productivity and profitability. These techniques are not only applicable to manufacturing, but also to service industries. In reconciling invoices, the tools help manage and monitor the time required for each phase in the process.

Statistical methods have been applied to quality improvement since the 1920s. In 1924, Walter A. Shewhart developed the statistical control chart concept. By the 1930s, statistical quality control methods were being employed at Western Electric, but were not widely used or accepted in industry [Ref. 10, p. 9]. World War II marked the beginning of industry acceptance as these techniques were used during the war. Reliability engineering emerged during the 1950s and 1960s and reinforced statistical quality control. These tools began spreading throughout industry in the late 1970s and early 1980s when U.S. companies discovered that their Japanese counterparts had been using them quite successfully since the 1960s. Statistical methods have spread exponentially since the early 1980s, and are now an industry standard.

The concept of Total Quality Management (TQM) is a useful management structure under which to implement statistical process control. DoD embraced TQM in many aspects of its operations during the 1990s, so using SPC to manage this process fits well with DoD' s management framework.

1. Tools available through SPC

Flow charts are one of the eight quality improvement tools used during SPC. Flow charts are particularly useful in developing process definition. They display the sequence of steps in the process and help the user understand the process flow. Prior to conducting any analysis, managers should develop flow charts for the process.

Histograms are a second quality improvement tool that can be used to see the data's shape, central tendency, and scatter or spread. This tool is used to manage the reconciliation process, but its use is limited due to the small data sets in this analysis. From the histogram and descriptive statistics, the user can determine the sample mean and sample standard deviation. The most important measure of central tendency is the sample mean. The variability of the data is measured by the sample standard deviation, which is the square root of the sample variation. The sample variation is the sum of the squared deviations of each observation from the sample mean, divided by the sample size minus one.

Box plots can help interpret histograms. Box plots are graphical displays that identify observations lying unusually far from the rest of the data, as well as the variability of the data and the mean. The box plot displays the three quartiles, the minimum, and maximum of the data in a rectangular box. The box encloses the interquartile range from the first to third quartile. A line is drawn through the box at the second quartile (which is the median). A line at either end extends to reach the outliers.

The control chart is one of the primary tools used in SPC [Ref. 10, p. 12]. Control charts plot a variable's mean and variation. The centerline represents the variable's mean if there were no unusual sources of variability in the process. Some variation will always be present, even in a perfectly controlled process. This is usually referred to as natural or inherent variation [Ref. 10, p. 130]. The upper and lower control limits are set so that nearly all of the observations will lie between these two lines if the process is in statistical control. Usually, the control limits are set at three standard deviations. If the data is

normally distributed, there is a .27 percent probability that an observation falls outside the control limits due to natural variation. As long as the observations remain within the control limits, the process is assumed to be in statistical control; no action is necessary. If an observation is plotted outside of the control limits, investigation and corrective action should be initiated to eliminate or resolve any unusual process variability. If observations fall within the control limits, but they behave in a systematic or non-random manner, the cause of the pattern should be investigated. In the case of reconciling invoices, some patterns have an important interpretation, like the downward trend in the time that a phase of the process takes; and some do not.

Warning limits at one and two standard deviations increase the control charts' sensitivity in detecting unusual observations. Thus, process mean shifts are detected more quickly, although the probability increases that a point is outside the control limits due to natural variation.

Control charts can also be used to estimate process capability. If the chart exhibits statistical control, we can estimate the mean and standard deviation from the control chart.

B. INTRODUCTION TO FLOW CHARTS USED FOR PROCESS DEFINITION

An essential part of systems analysis is to understand the system that one is analyzing. One common tool that can be used to understand systems is flowcharting. The primary advantage to using flowcharts is that they pictorially display the steps in the process. Most people understand the displays much better than written descriptions. No flowcharts exist for this system. The most current version of SECNAVINST 4200.94 is used to develop the flowcharts contained in Figures 22 through 25; the DFAS standard operating procedures are used to develop those in Figures 26 and 27. After developing the flow charts, area experts at DFAS and CNSL verified that they accurately reflect the reconciliation process.

1. Overview of the reconciliation process

The flow chart depicted in Figure 22 summarizes the reconciliation process. The greatest differences between the three time frames is in transmitting the invoice from the bank to the ship and the method ships use to forward the certified invoice to the paying activity. RMNB invoices are sent to all activities by mail; the ship mails a hard copy of the certified invoice to the paying activity after reconciliation. U.S. Bank invoices are also mailed to ships for reconciliation, but certified invoices are forwarded to the paying activity by naval message or mail. Citibank invoices are both transmitted via SALTS and mailed to the activities for reconciliation. However, using CitiDirect and enhancements to the SALTS program, electronic transmission is rapidly becoming the primary means for a ship to both receive invoices and forward certified invoices for payment. Electronic transmission allows the ship to access the invoice electronically through the CitiDirect program or receive it via SALTS. If accessed electronically through CitiDirect, Citibank then electronically forwards it to the paying activity. Some ships already receive invoices via SALTS and transmit the certified invoice to the paying activity via SALTS. Electronic submission is being implemented, but no ships in the samples analyzed used this new process for reconciliation. Electronic submission and certification should decrease the reconciliation time required.

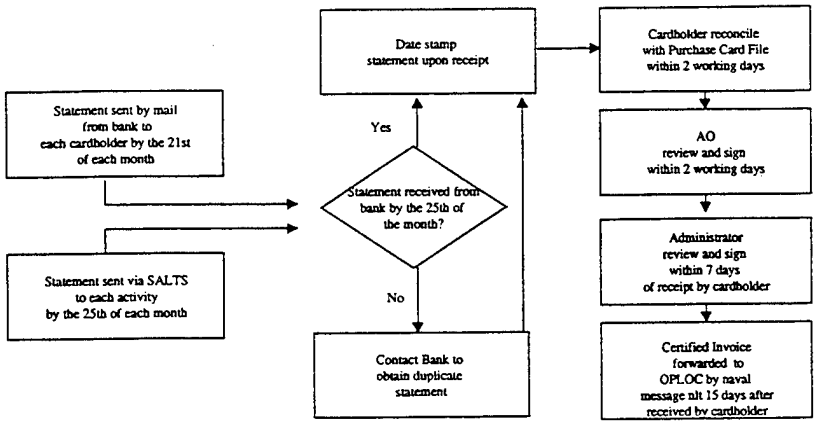


Figure 22 A flow chart depicting the overall reconciliation process for Citibank without SALTS certification.

2. Reconciliation

Figure 23 reflects the cardholder's process to certify that the charges on the invoice are correct and proper. An added benefit is that the cardholder can use this flowchart to assist in decision making while certifying invoices for payment. On the working level, a flowchart is often easier to use than a manual. This flowchart reflects the "pay and confirm" policy. Before implementing this policy, the material or service had to be received prior to certification for payment.

Figure 24 reflects the process that the AO uses to certify that the invoice was reconciled properly. This flow chart can be utilized by the AO to review all cardholder reconciliation packages. Figure 25 reflects the process that the Administrator uses to review the reconciled invoice. This flow chart can be utilized by the Administrator to review all cardholder reconciliation packages. On some ships, the AO and the Administrator may be the same person.

Actions are being taken to reduce some of the time lags built into the system by taking advantage of electronic transmission and data entry. These changes have great

potential for reducing the time that it takes to certify invoices for payment. Redundancies are built into the system to detect fraud if it occurs; these redundancies serve a purpose in this system.

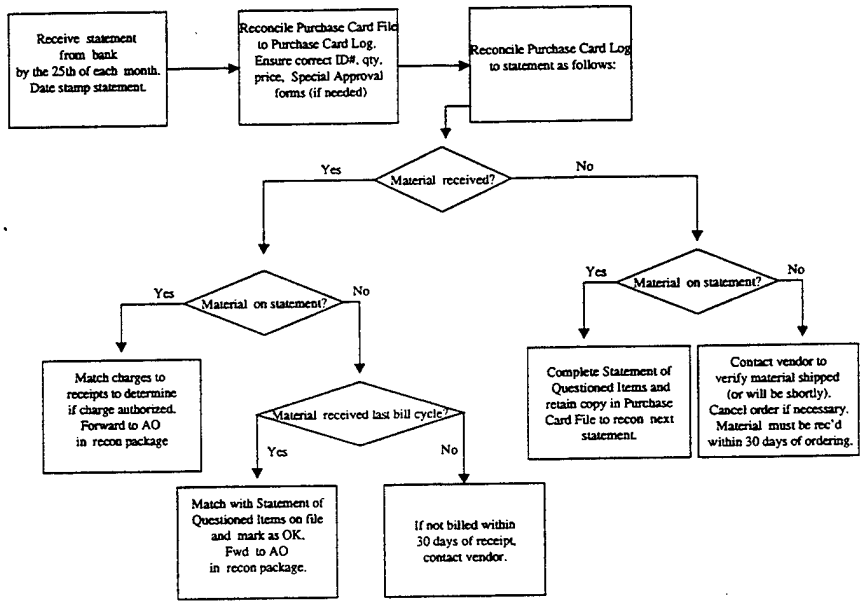


Figure 23 A flow chart for use by a cardholder.

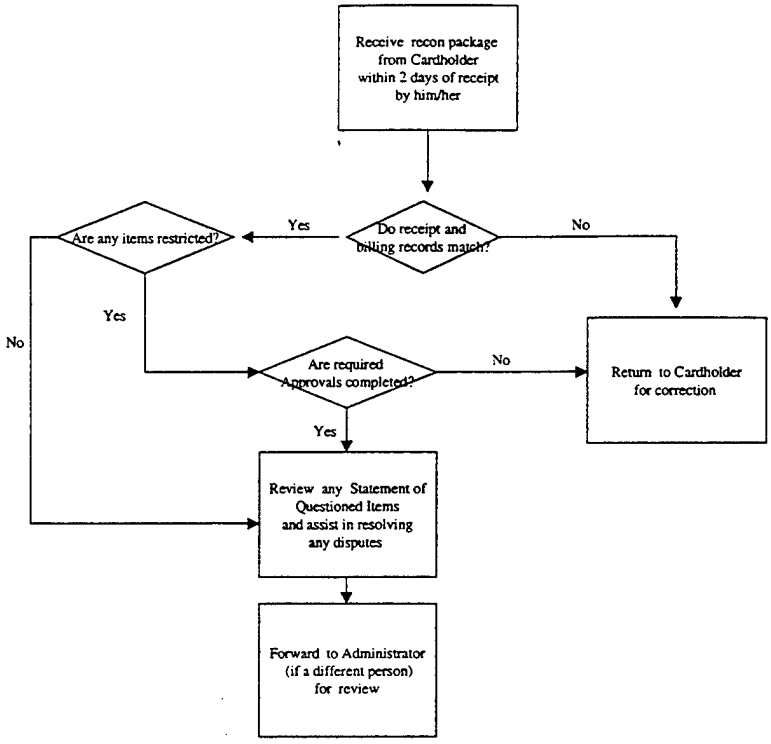


Figure 24 A flow chart for use by an AO.

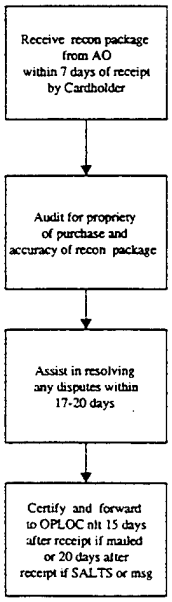


Figure 25 A flow chart for use by an Administrator.

3. Payment Processes

Figure 26 summarizes the process that the paying activity uses to pay invoices once they are received from the ships. Figure 27 provides a detailed chart for the process of certifying an invoice for payment and any suspense actions taken. The area for greatest improvement, manual data entry, is already being addressed. The new programs, CitiDirect and SALTS, provide the capability to automatically enter electronic data into the DFAS system. This improvement will not only speed up the process of paying invoices, but eliminate the potential for human data entry error.

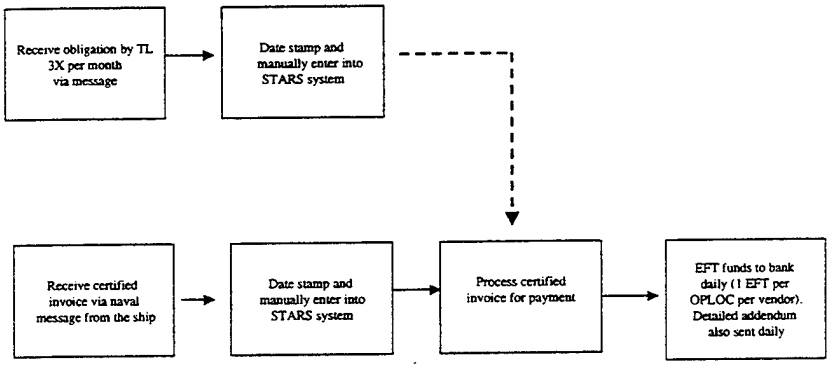


Figure 26 A flow chart depicting an overview of the process of paying a reconciled invoice at OPLOC.

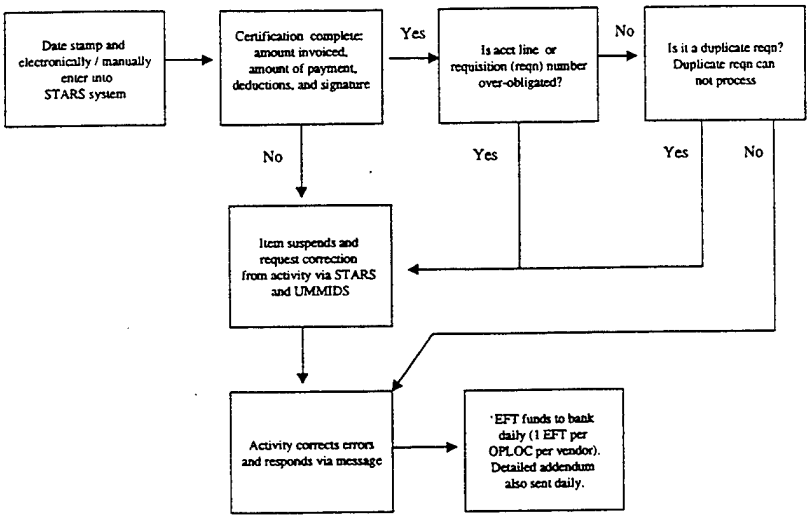


Figure 27 A flow chart depicting an overview of the process of certifying an invoice for payment at OPLOC (including suspense actions).

C. SPC TOOLS

One problem that this research addresses is the lack of tools to monitor the reconciliation process on the fleet level. These management tools should be informative and easy to use. They should assist in answering the following questions:

- How to quickly and easily identify the activities that should receive some additional management attention?
- How to identify if an activity's performance is improving or degrading over time?
- How to identify those efficient activities that deserve praise?

Using the statistical control techniques currently employed by industry, fleet managers and other major claimants can monitor and manage the reconciliation process. These statistical control techniques were developed under the Total Quality Management (TQM) framework. [Ref. 10, p. 10] By using one of the commercially available

programs that managers use to generate SPC tools, fleet managers and other major claimants can monitor and manage the reconciliation process more efficiently.

These statistical techniques monitor and track the times to receive the invoice (InvActRec), submit the invoice to the paying activity (ActRecOPLOCRec), and pay the invoice (OPLOCRecPay). As discussed in Chapter III, ActRecOPLOCRec is the phase that is not stable. We will concentrate on this variable, but will also look at the other variables. Each variable directly impacts the time required for the reconciliation process; activities may want to monitor particular variables for differing reasons.

1. Graphs which can be produced

It should be noted that SPC assumes that the sample data is normally distributed when generating control limits for the charts. We use SPC primarily for exploratory analysis, so the assumption of normality is acceptable due to the large population of ships that we are sampling from. Additionally, this assumption is robust to deviations. [Ref. 10, p. 130] If desired, the user can manually set the control limits. The author did not do this in generating charts for this thesis, because the results in Chapter III indicate that any deviations from the normal distribution in the sample data will reflect this robustness.

- Xbar charts graphically depict the mean value of the variable being analyzing over time. This chart permits the user to see trends in the mean over time, as well as sudden shifts in the mean. If only one UIC is being analyzed, an I chart will be used to depict the individual observations.

- S, R and MR charts graphically depict the variation in the variable that is being analyzing over time. These charts permit the user to see trends in the variation over time, as well as sudden shifts in the variation. Minitab has several methods to estimate standard deviation, depending whether or not there are multiple observations or individual observations. The default method uses a pooled standard deviation, which is usually the most efficient. For smaller samples, the range can be used to estimate standard deviation. S charts use standard deviation to chart the variation, and R charts use the data range to chart the variation. MR charts are primarily used when analyzing with a single UIC (single observations). MR charts graphically depict the moving range in the variable that is being analyzed over time. The moving range is of length two, since consecutive values have the greatest chance of being alike. The length of the moving range can be adjusted if needed.

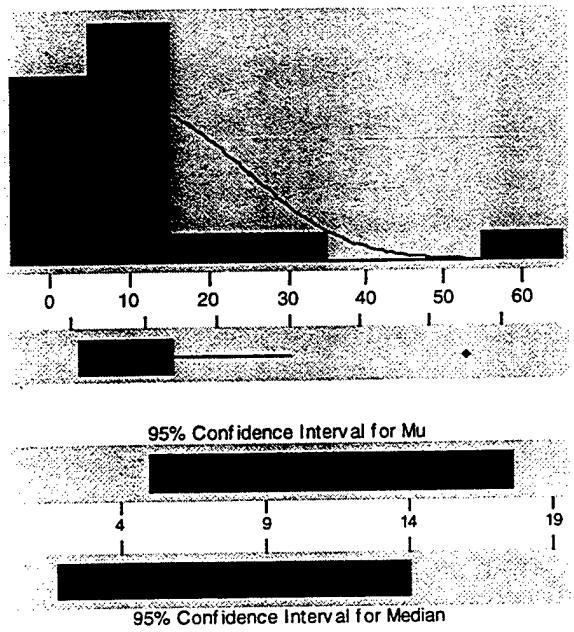
- Descriptive statistics charts generate a histogram and box plots of the data. Point estimates and 95% confidence intervals for the mean, standard deviation, and median are calculated and listed. The minimum, maximum, and quartiles are also calculated and listed.

- The "process six-pack" is also a very useful tool. The process six-pack plots six charts to assess process capability. These charts include: the Xbar and S/R/MR chart, a run chart of each month's data points, a histogram of the data, a normal probability plot showing the data distribution compared to the normal distribution, and the capability plot. The capability plot shows how the process compares to the specifications set. The histogram is overlaid with the normal curve, using the process mean and standard deviation. This helps visually assessing the normality assumption. The six-pack assumes that the data is normally distributed. These tools are still useful if this assumption is not satisfied, and are very robust to deviations from this assumption.

2. Use of SPC tools on the ship level

a) An example of a ship that is managing the reconciliation process well

The first tool that can be utilized is the descriptive statistics chart. This chart permits managers to look at the data aggregated over time. Figure 28 reveals that the data for ActRecOPLOCRec in this ship's case is right skewed with at least one extreme value. The extreme values are highlighted and easier to identify in the box plot directly below the histogram. Once identified, the extreme value can be investigated. In this case, the outlier is due to the ship first implementing the purchase card and becoming familiar with the invoice reconciliation process. When the ship first started using the purchase card, they had one month during which they took an abnormally long time to reconcile invoices. The right hand column of Figure 28 gives the summary statistics for this data.



Variable: ActRec-OPLOC

Anderson-Darling Normality Test	
A-Squared:	1.512
P-Value:	0.000
Mean	11.3158
StDev	13.0258
Variance	169.673
Skewness	2.33743
Kurtosis	6.76688
N	19
Minimum	1.0000
1st Quartile	1.0000
Median	9.0000
3rd Quartile	14.0000
Maximum	55.0000
95% Confidence Interval for Mu	
5.0375	17.5940
95% Confidence Interval for Sigma	
9.8425	19.2629
95% Confidence Interval for Median	
1.8640	14.0000

Figure 28 Descriptive statistics for the amount of time that the ship takes to process the invoice for UIC 05840.

Figures 29, 30, and 31 display the process capability six-pack charts for the three primary variables that we have been emphasizing. Notice that the I chart in the upper left corner of Figure 29 shows an increase for the eleventh data point. It is not outside of the control limits, but it is of some interest. This point reflects the time during which the contract for purchase cards shifted from U.S. Bank to Citibank; thus a small increase in reconciliation times might be expected. This increase is seen in almost all of the other ships sampled, and in many cases is much more pronounced.

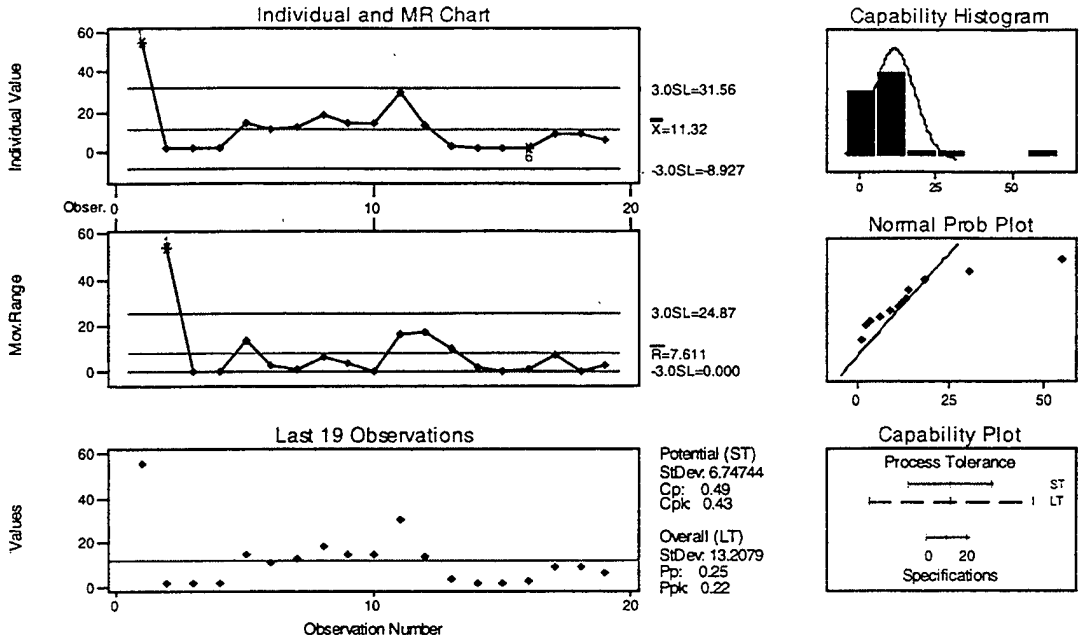


Figure 29 Process capability six-pack for the amount of time that the ship takes to process the invoice for UIC 05840.

Figure 30 shows that the time an invoice took to get to the ship is extremely large at the beginning of the process, but has been random since then, with a small increase around the thirteenth observation. Figure 31 shows the same pattern for the time that the invoice is at the paying activity before being paid. It should be noted that the ship is meeting its goal for reconciliation time, and the time that the invoice remains unpaid at the paying activity remains low. As a result, the entire reconciliation process for this ship is 22 days. This is below the 30 day window permitted for reconciliation before interest is assessed.

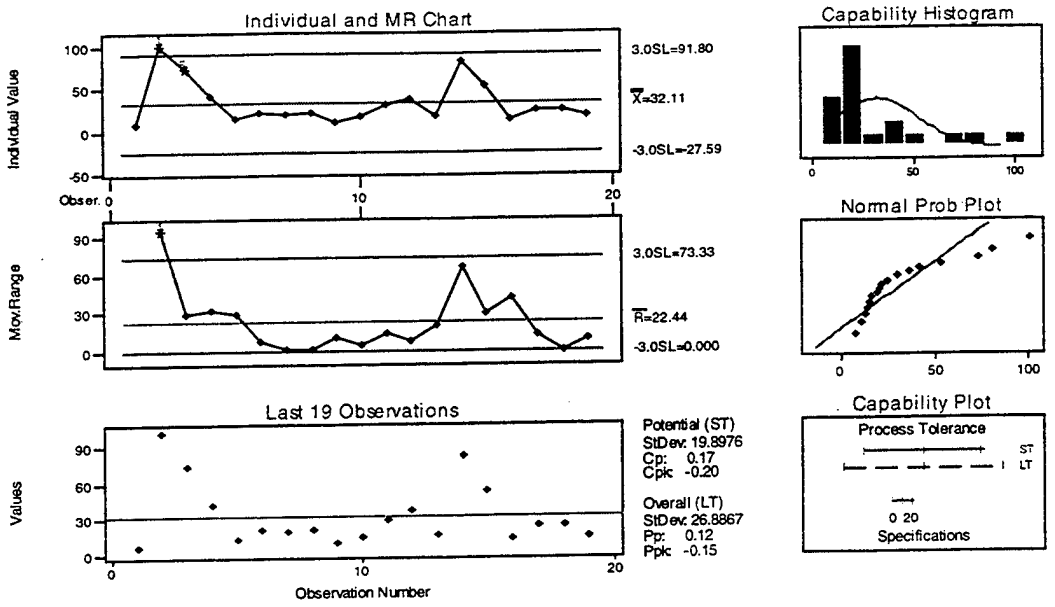


Figure 30 Process capability six-pack for the amount of time that it takes from invoice transmission from the bank until date stamped by the ship for UIC 05840.

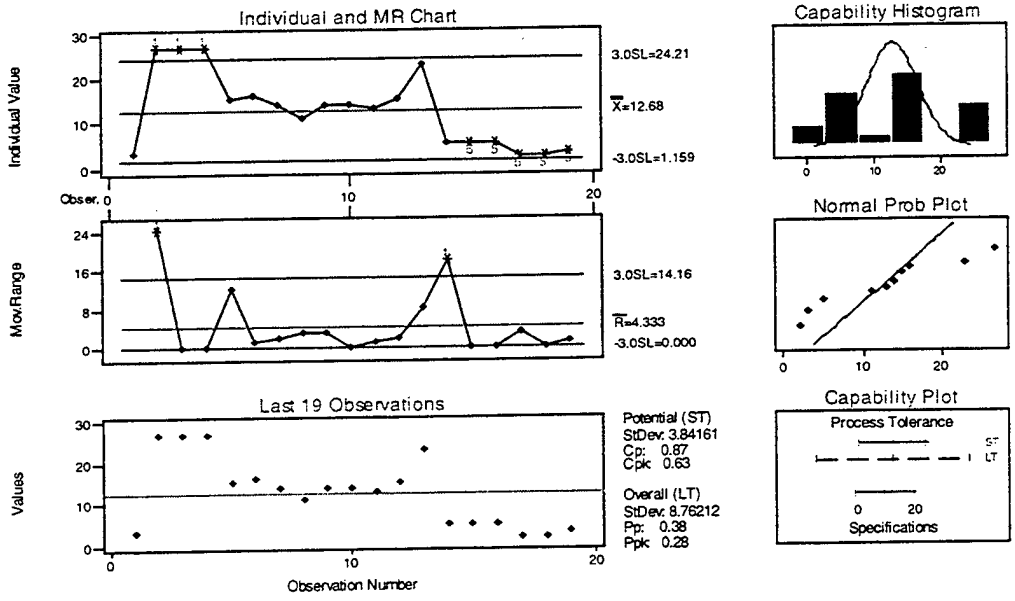


Figure 31 Process capability six-pack for the amount of time that it takes from invoice receipt by OPLOC until the invoice is paid for UIC 05840.

SPC permits the user to delete the outlying point from calculations if it reflects an identified cause. Figures 32, 33, and 34 demonstrate the process of removing an outlying data point from calculations, but permitting the point to remain in the database for future reference. This is done to remove data points with known reasons for their variability, permit narrower control limits and provide more accurate sample statistics with which to monitor process performance. When the sample data is plotted in Figures 28 and 29, there is one data point that remains outside the control limits. This indicates that the data point would not be expected as a part of normal process variation. After investigating this data point, it appears to reflect bank shifts and familiarization with the new bank policies and invoice format. As a result, that data point is deleted.

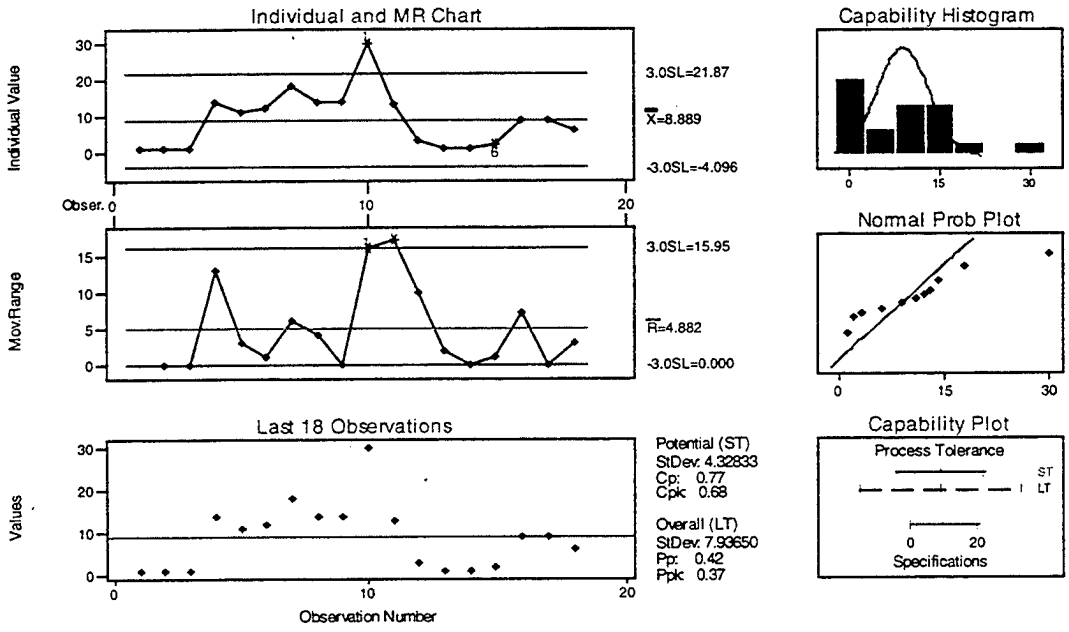
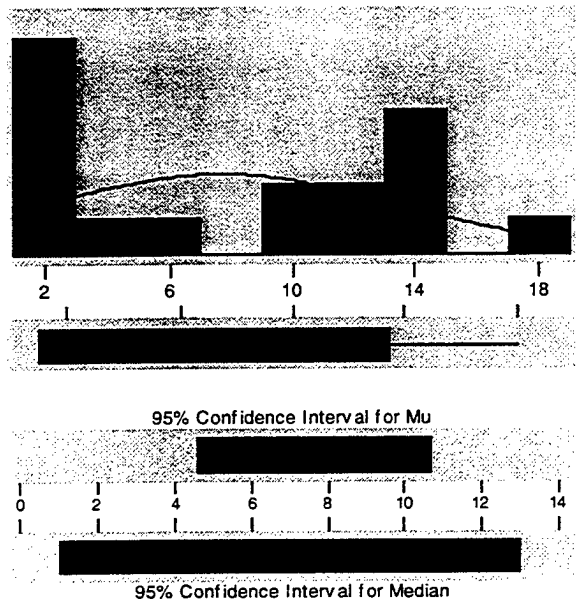


Figure 32 Process capability six-pack for the amount of time that the ship takes to process the invoice after deleting data point two for UIC 05840.

Figure 32 displays the new control charts after data point two is removed from the calculations. Now it appears that data point ten is not within the control limits set, and must be investigated. Data point ten appears to result from the bank shift from RMNB to U.S. Bank, so it can be removed from consideration as well. Figures 33 and 34 display the new statistics and control charts that result after these two data points are removed from the calculations.



Variable: ActRec-OPLOC

Anderson-Darling Normality Test	
A-Squared:	0.872
P-Value:	0.020
Mean	7.64706
StDev	5.95757
Variance	35.4926
Skewness	0.135347
Kurtosis	-1.56496
N	17
Minimum	1.0000
1st Quartile	1.0000
Median	9.0000
3rd Quartile	13.5000
Maximum	18.0000

95% Confidence Interval for Mu	
4.5840	10.7102
95% Confidence Interval for Sigma	
4.4370	9.0670
95% Confidence Interval for Median	
1.0240	12.9760

Figure 33 Descriptive statistics for the amount of time that the ship takes to process the invoice after deletion of data points one and ten for UIC 05840.

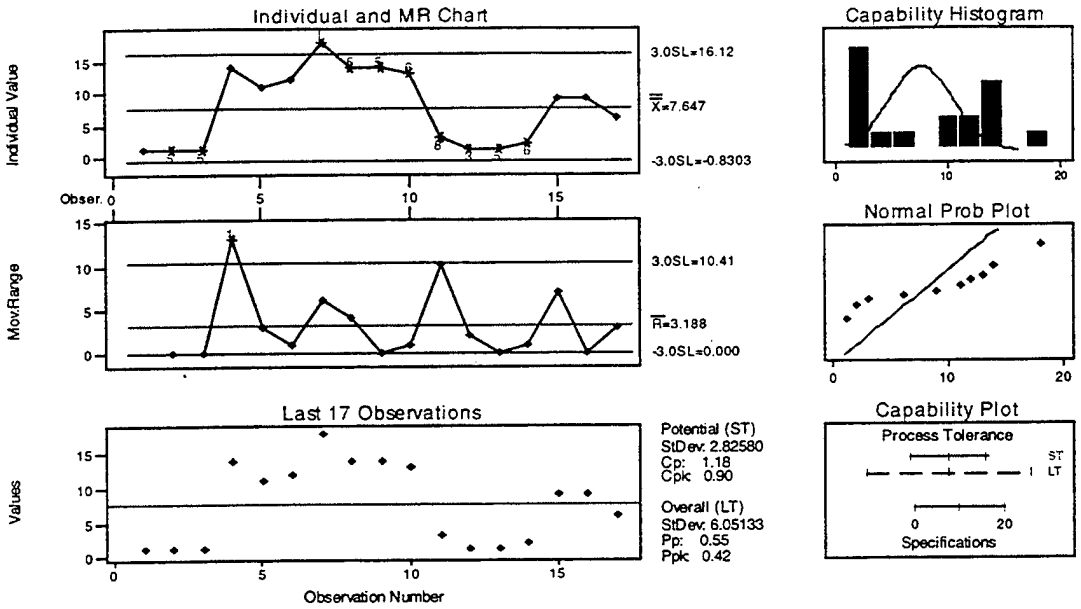
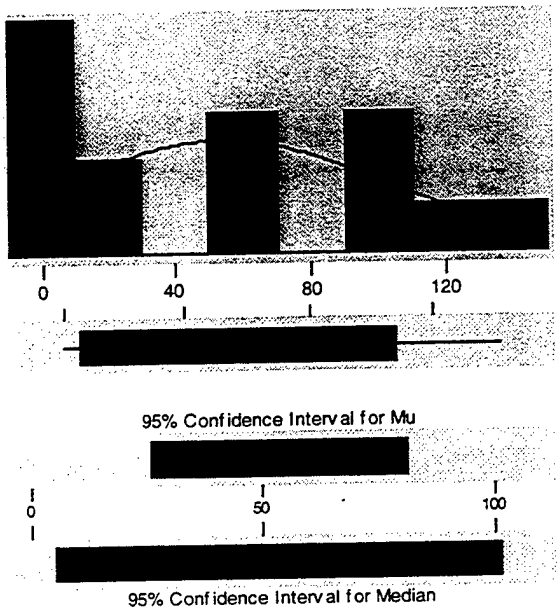


Figure 34 Process capability six-pack for the amount of time that the ship takes to process the invoice after deletion of data points one and ten for UIC 05840.

Notice in Figure 32 that the confidence intervals are significantly smaller and the sample statistics more accurately reflect the ship's performance. This is also true for Figure 34, the control limits are much smaller, permitting a more accurate view of the process after removing identified causes of variation. The advantage to performing this analysis is that the control chart limits are narrowed and the process statistics are more realistic. This is similar to peeling an onion. The outlying data points that exceed normal random variation in the process are identified, permitting the manager to investigate and resolve the causes. As a cause is identified and resolved, that point may be removed to make the control limits and statistics more accurate. Narrower control limits identify additional outlying points that should be investigated, and their causes resolved. If the user is analyzing multiple UICs, this procedure will help identify activities that are the outliers and may require further analysis.

b) An example of a ship that is not managing the process well

For comparison, an unstable ship's process is analyzed. This ship may require some assistance in managing the process to meet time frame goals. Figure 35 reveals that the ActRecOPLOCRec data for this ship has so much variability that it appears uniformly distributed. This pattern is also reflected on the box plot. Figure 36 shows that this ship has a decreasing time trend, reflecting a learning curve, until the purchase card contract shifted to Citibank. This ship's reconciliation times increased each time that the bank contract shifted. This ship may need some assistance or additional training in reconciling invoices. These plots can identify either increasing or decreasing trends.



Variable: ActRecOPLOCR

Anderson-Darling Normality Test	
A-Squared:	0.645
P-Value:	0.074
Mean	53.6667
StDev	49.5633
Variance	2456.52
Skewness	0.412798
Kurtosis	-1.32292
N	15
Minimum	0.000
1st Quartile	5.000
Median	58.000
3rd Quartile	108.000
Maximum	142.000

95% Confidence Interval for Mu	
26.219	81.114

95% Confidence Interval for Sigma	
36.287	78.166

95% Confidence Interval for Median	
5.374	101.277

Figure 35 Descriptive statistics for the amount of time that the ship takes to process the invoice for UIC 21531.

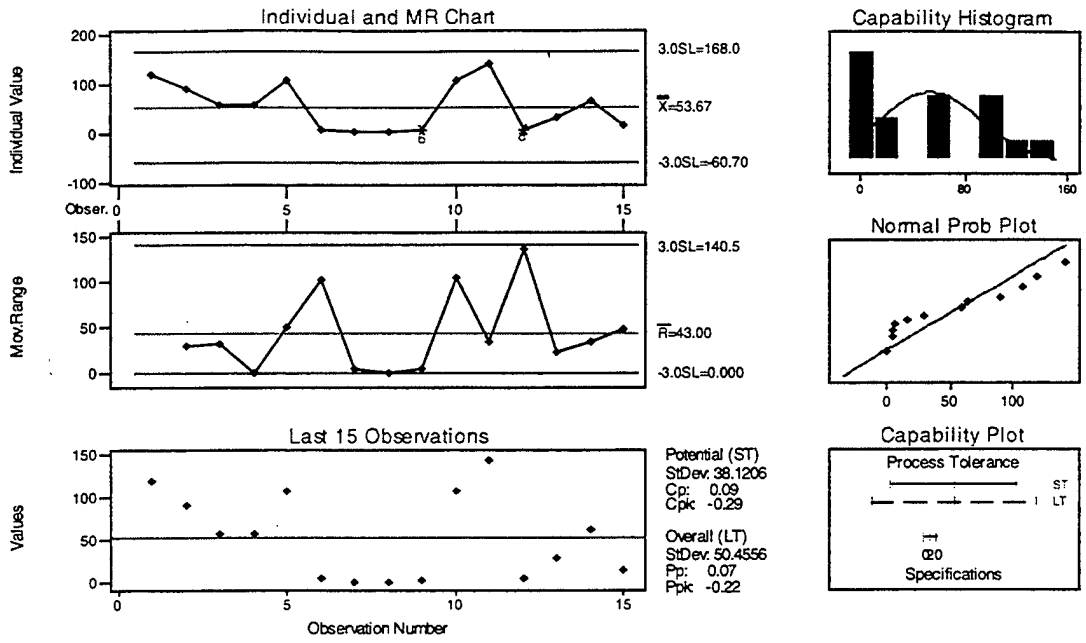


Figure 36 Process capability six-pack for the amount of time that the ship takes to process the invoice for UIC 21531.

Figures 36, 37, and 38 display the process capability six-pack charts for the three primary variables that we have been emphasizing. Notice that the I chart in the upper left corner of Figure 36 shows that this ship had a decreasing time trend reflecting a learning curve, until the purchase card contract shifted to Citibank. This ship's reconciliation times increased each time the bank contract shifted. The variation in this ship's data result in very large control limits, so no data plots outside of the limits. Figure 37 shows that the time it took the ship to receive the invoice has varied over time. Figure 38 shows that the time that an invoice remains at the paying activity is centered around the mean of twenty-six days. The ship is not close to meeting its goal for reconciliation time, and the time that the invoice is at the paying activity awaiting payment remains high as well. As a result, the entire reconciliation process for this ship is approximately 80 days. This is significantly above the 30 day window permitted for reconciliation before assessing interest.

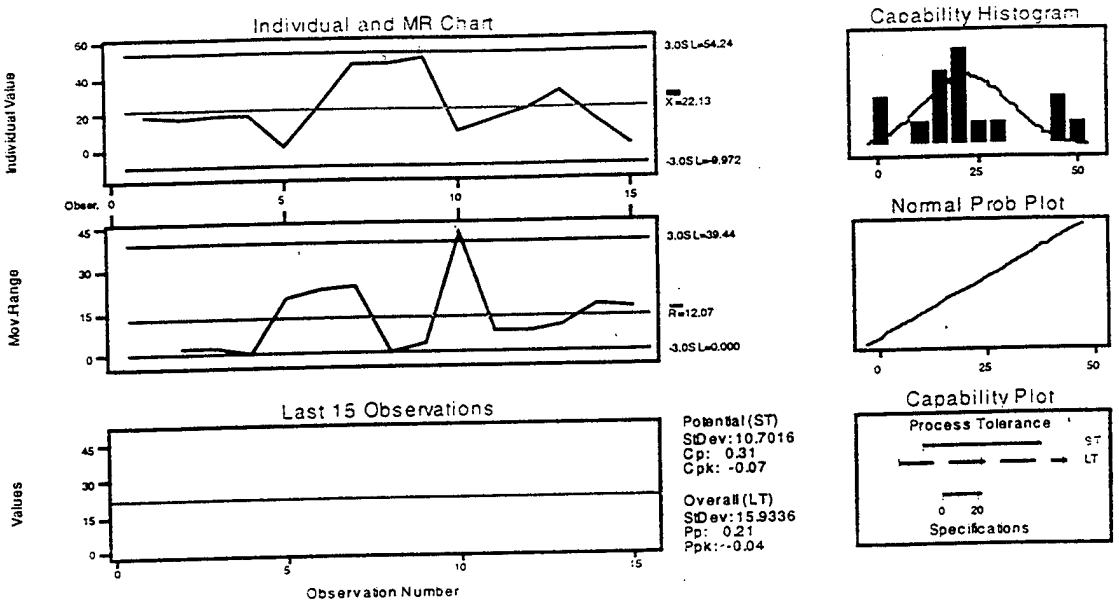


Figure 37 Process capability six-pack for the amount of time that it takes from invoice transmission from the bank until date stamped by the ship for UIC 21531.

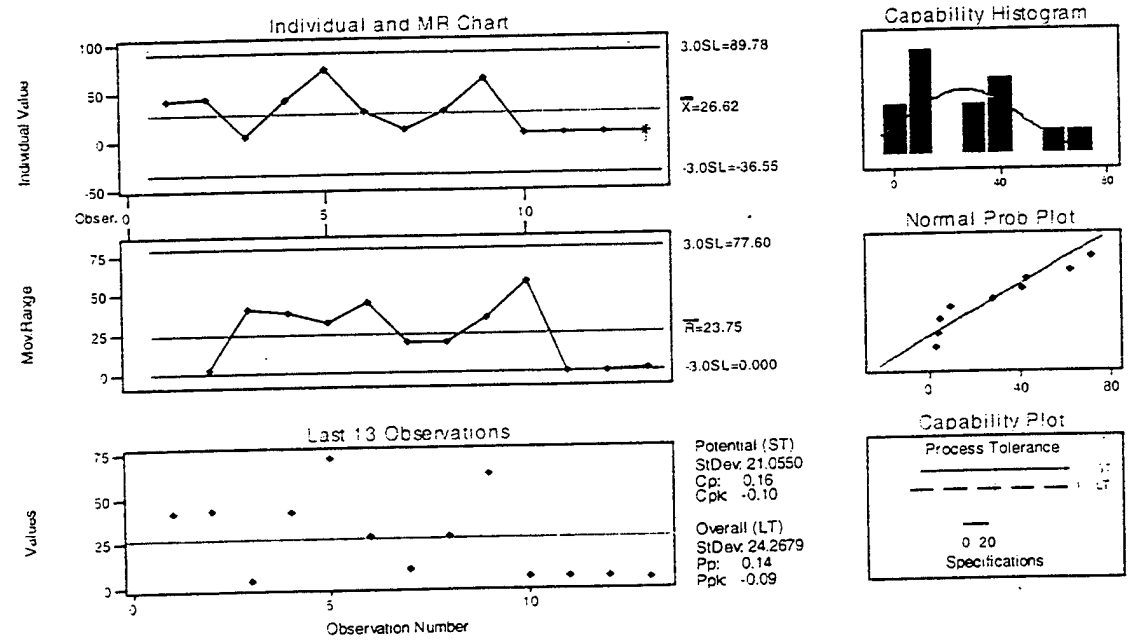


Figure 38 Process capability six-pack for the amount of time that it takes from invoice receipt by OPLOC until the invoice is paid for UIC 21531.

c) *An example of identifying trends*

These graphs can be used to identify ships that are improving and those that are taking longer to reconcile invoices. Trends in the data are easy to identify using control charts. Figure 39 illustrates a ship that is reconciling invoices in a more timely fashion. This ship has extremely long reconciliation times at the beginning of the sample, but has significantly reduced the time to reconcile invoices. This information can help fleet managers; they can contact ships like the one depicted in Figure 39 to determine what that ship has done to improve its reconciliation process and identify their lessons learned. This information can then assist ships with below average performance.

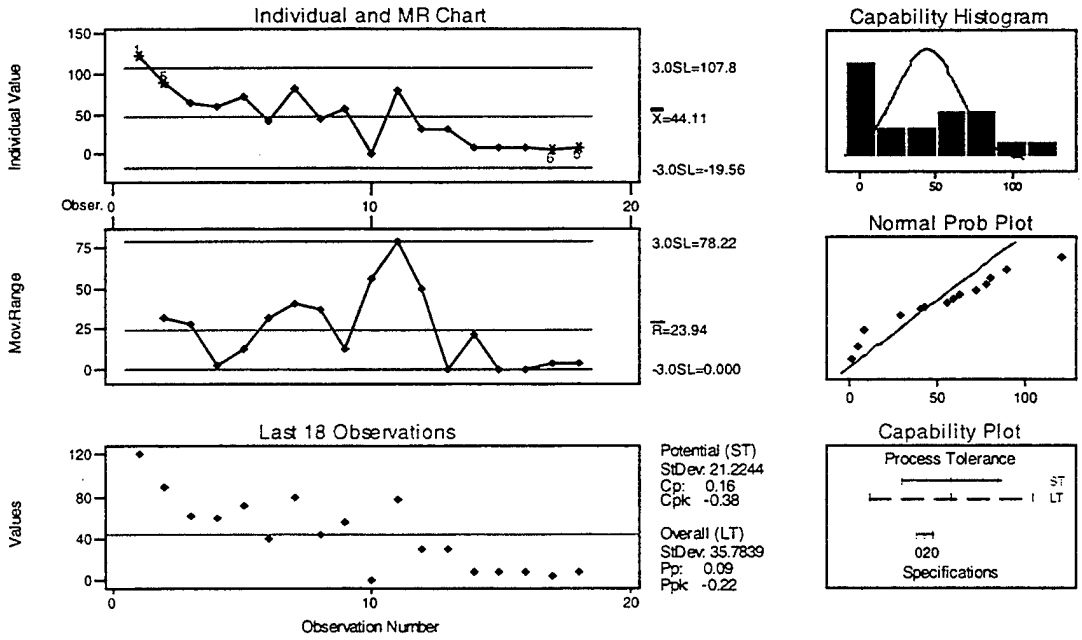


Figure 39 Process capability six-pack for the amount of time that the ship takes to process the invoice for UIC 21054.

Conversely, control charts can assist in identifying ships that may require some guidance by the fleet managers. Perhaps the ship has been improving, but is no longer showing any improvement. This is not a cause for concern unless the phase being analyzed has leveled out with the ship consistently not meeting goals. Unless the fleet

manager intervenes and provides some assistance, the ship will probably never meet reconciliation goals.

d) An example of the interaction between variables

Figures 40 and 41 depict another factor that managers consider in analyzing this process. The manager must remember that these variables are related and not always independent. For example, Figure 40 leads the manager to believe that this ship is effectively managing the reconciliation process. The charts reveal a distinct downward trend in the time the ship takes to reconcile invoices. However, in Figure 41, as the variable ActRecOPLOCRec decreases, there is an accompanying upward trend in the variable InvActRec. A manager may want to examine whether these two are related. It is possible to "game" the system by date stamping the invoice as it leaves the ship; this reduces the time measured by the variable ActRecOPLOCRec; it would increase the variable InvActRec. In this case, it can not be resolved whether these offsetting trends reflect random variation or whether they area consequence of the ship's policy on date stamping invoices.

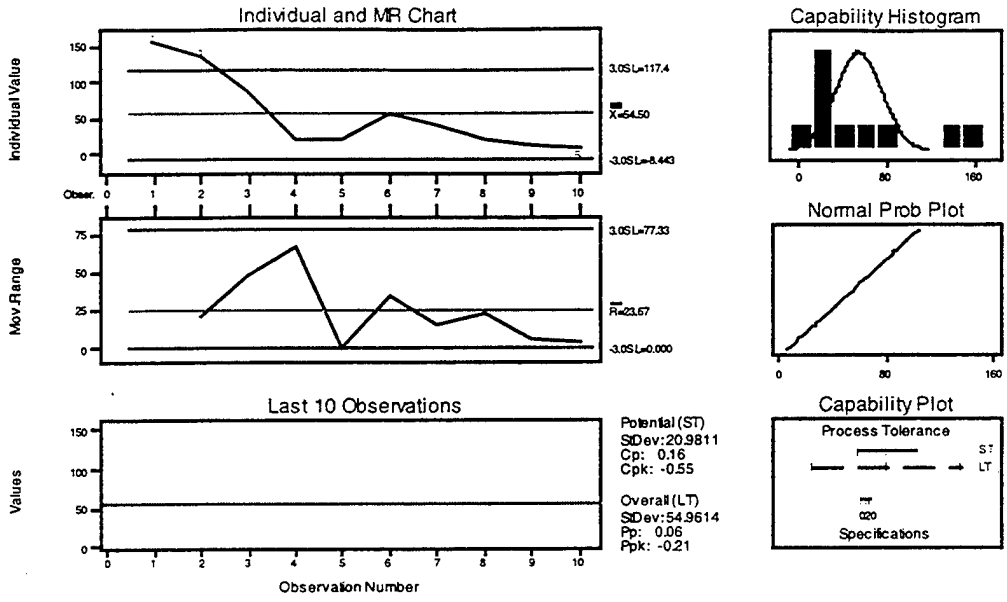


Figure 40 Process capability six-pack for the amount of time that the ship takes to process the invoice for UIC 20590.

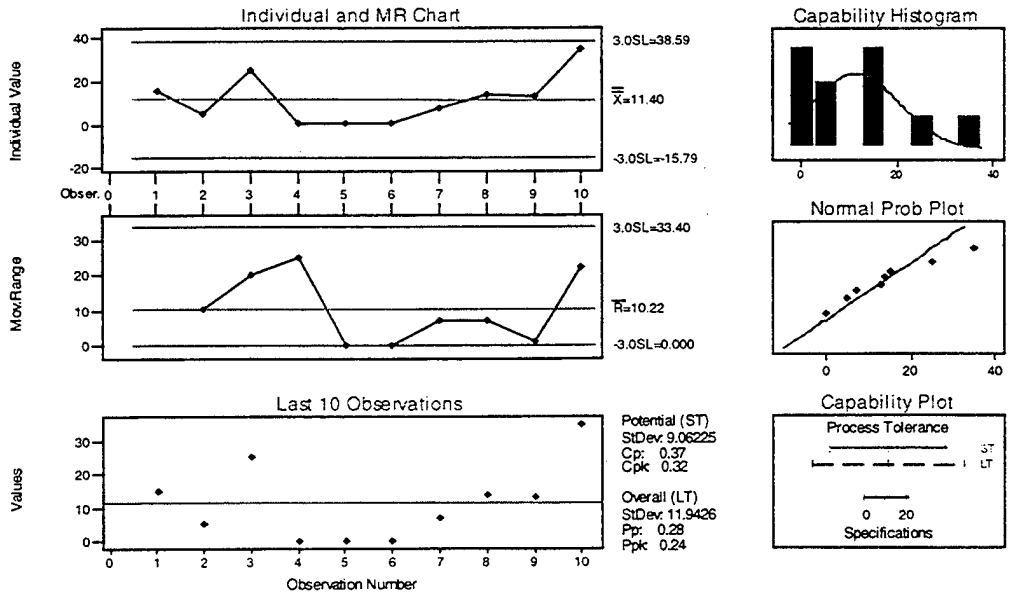


Figure 41 Process capability six-pack for the amount of time that it takes from invoice transmission from the bank until date stamped by the ship for UIC 20590.

3. An example of multiple UICs: CNSL and CNSP Rank 1 ships

Multiple UICs can be viewed as an aggregate. Figures 42 and 43 represent the Rank 1 ships sampled from CNSP and CNSL. Figure 43 reflects a distinct downward trend in mean reconciliation times with small increases when there was a shift in the bank holding the purchase card contract. Figure 42 does not reflect this trend; the times have remained within or close to the goals set. One item that might be investigated is slight increase in variability over the past six months in Figure 42.

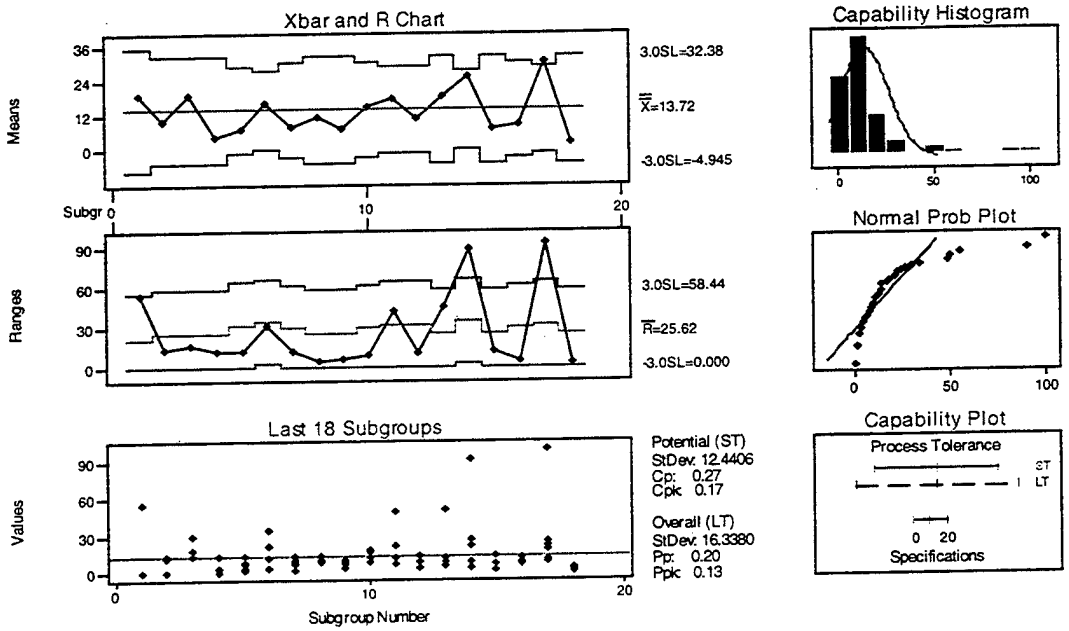


Figure 42 Process capability six-pack for CNSP Rank 1 ships.

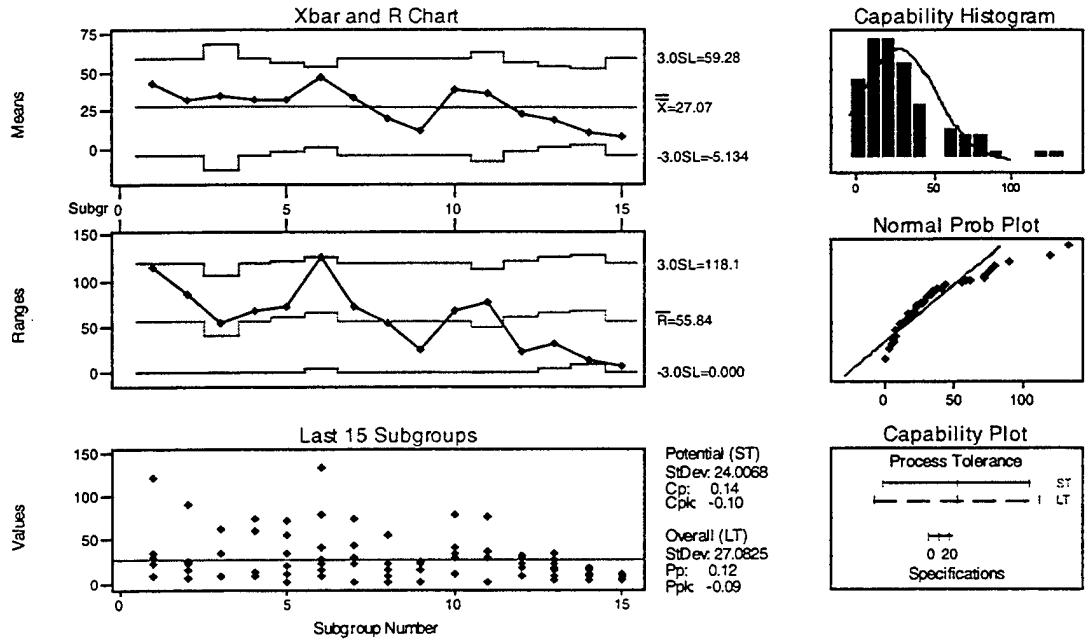


Figure 43 Process capability six-pack for CNSL Rank 1 ships.

4. Using the SPC tools to draw conclusions and recommendations for process improvement

a) An example of ships that are not date stamping the invoice upon receipt

During this analysis, it appears that some ships are not date stamping their invoices. This inflates the amount of interest paid since the interest "clock" begins when the invoice is date stamped by the ship. If there is no date stamp on the invoice, the invoice date is used to calculate interest payments. Interest is self-assessed by DFAS from 30 days after the ActRec date until the invoice is paid. Figure 44 represents a ship that apparently did not date stamp their invoices for nine months. This can be seen by the flat area on the I chart reflecting a zero value for InvActRec during this period. This means that the invoice date was used to calculate interest due. This did contribute to the results seen in Figure 45. Once the ship starts date stamping the invoices, the variable

InvActRec increases to approximately the fleet average, and the variable ActRecOPLOCRec decreases.

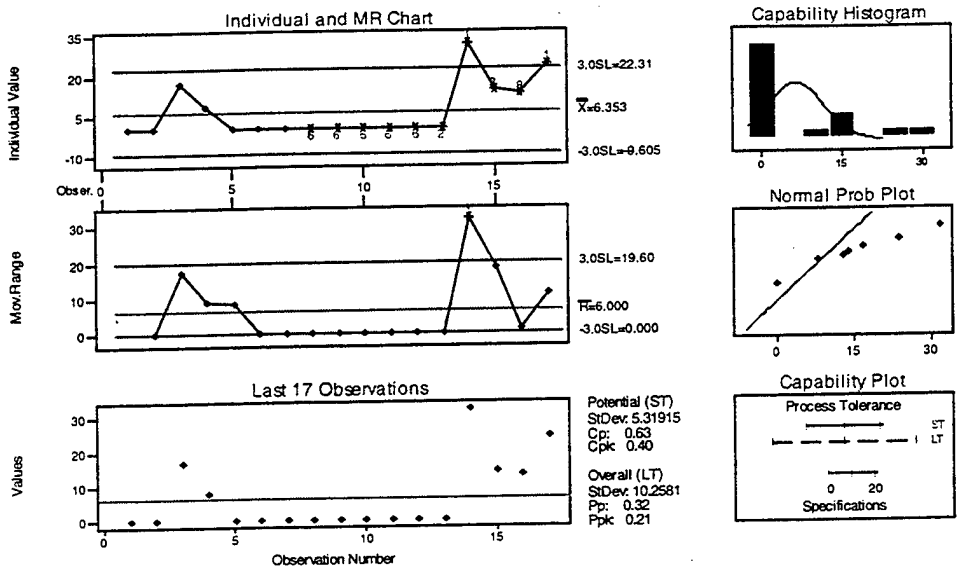


Figure 44 Process capability six-pack for the amount of time that it takes from invoice transmission from the bank until date stamped by the ship for UIC 20012.

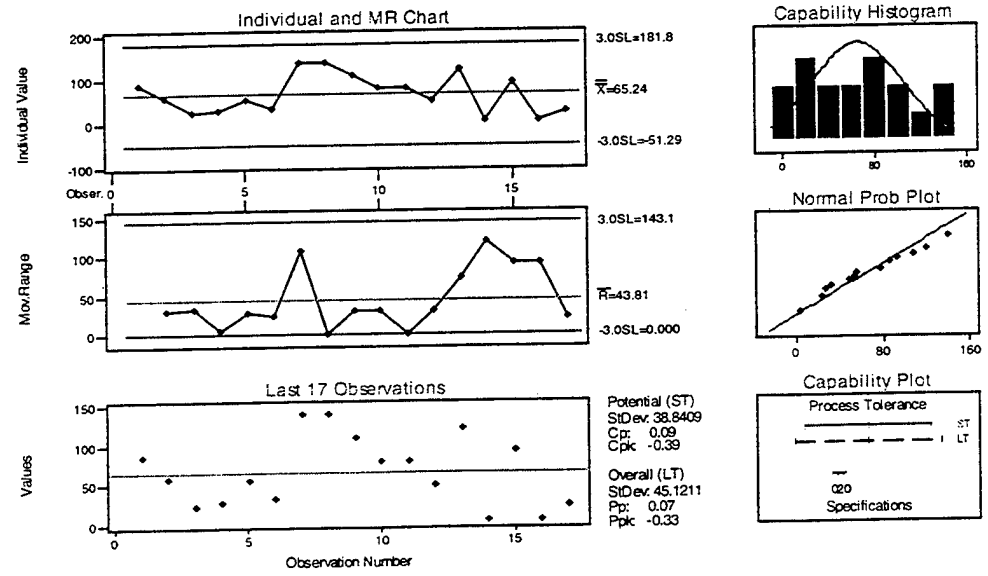


Figure 45 Process capability six-pack for the amount of time that the ship takes to process the invoice UIC 20012.

b) *An example of problems with the policy of "pay and confirm" and rolling balance*

The last example identifies a specific cause for change in the process. During interviews with fleet experts, one common cause is the ship's apparent confusion with the "pay and confirm" concept and with rolling balances. One ship's control charts illustrate how this problem is identified using SPC. Figure 46 shows that this ship takes longer than normal to reconcile invoices around data point nine. After that, the time decreases steadily. Interviews indicate that this ship initially had some difficulty with "pay and confirm" and rolling balances, but has improved over time since then. It appears that they have managed the process within goals for the past five months.

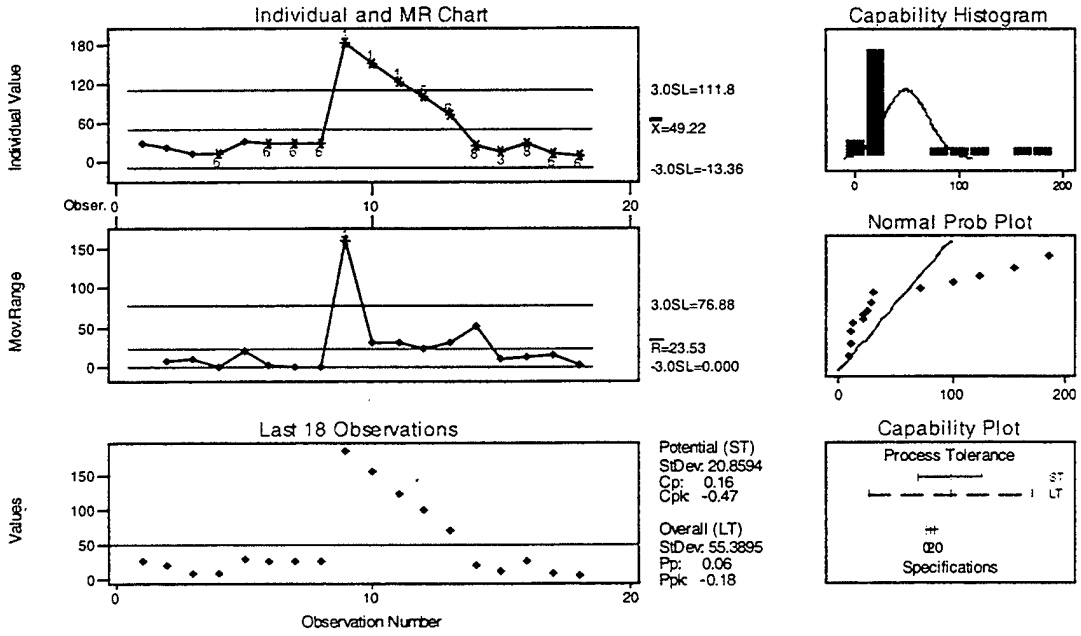


Figure 46 Process capability six-pack for the amount of time that the ship takes to process the invoice for UIC 21107.

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V. CONCLUSION AND RECOMMENDATIONS

This research provides insight into the process of reconciling purchase card invoices even though it only focuses on two specific fleets. The tools identified in Chapter IV can be used by any purchase card manager to monitor their units' reconciliation process. The findings in Chapter III apply specifically to CNSL and CNSP, but apply to other activities as well.

This research reveals that the shipboard phase of the reconciliation process is the least stable and often has the largest mean duration. Other phases of the process have high mean duration, but usually exhibit less variability. The shipboard phase appears to have the most impact on the reconciliation process. Training for procedures and policies will help ships that are struggling with these concepts. This research identifies three specific areas in which further training might assist some ships: understanding rolling balance; understanding the "pay and confirm" policy; and recognizing the importance of date stamping invoices.

SPC can also help managers identify which ships would benefit from additional training in these areas. Most ships have initial problems implementing reconciliation policies, but many significantly decrease process times as they gain experience. SPC tools can help managers identify high performance ships; lessons learned from these units can be provided to others that have large invoice reconciliation times.

Data analysis techniques also reveal that ship ranking is significant. Fleet area experts are able to accurately rank ships overall, but SPC tools avoid personal bias by using time series analysis to increase objectivity in categorizing ships. SPC tools permit managers to avoid a bias resulting from one or two good (or bad) months' performance when categorizing ships. As the fleet area experts are aware, the ships that appear to have the longest process duration are the ships ranked the worst. The significant difference between CNSL and CNSP are across lower ranked ships. The CNSL high ranked ships' process times are similar to those in CNSP, but the lower ranked ships have significantly worse process times than their counterparts in CNSP. However, many CNSL ships' mean duration times improve significantly between January 1998 and June

1999. The challenge for CNSL is to focus on the lower ranked ships to achieve parity with CNSP ships.

Systems analysis and data analysis techniques reveal that the bank shifts and policy changes significantly reduce the time that it takes ships to reconcile invoices. Overall, the mean reconciliation process time for all ships decreases between January 1998 and June 1999. Flow charts reveal potential improvements that are already being tested and implemented. Improvements like SALTS transmission and certification and CitiDirect have the potential to further reduce the time that this process takes.

In addition, the flow charts reveal that the obligation process requires further attention. The process of reconciling invoices is intrinsically tied to the obligations, and managers must ensure that the reconciled invoice does not arrive at the paying activity prior to the obligation. If the reconciled invoice is received prior to the obligation, the invoice will be suspended due to insufficient funds. Currently, ships transmit their obligation documents three times a month, usually obligating the minimum amount required. Interviews suggest that this time differential delays invoice payment at the paying activity.

Managers can use SPC tools presented in Chapter IV to identify lower ranked ships in a non-subjective fashion and to monitor ships' performances over time. This facilitates more accurate analysis of process performance. Graphical tools permit managers to look at the unit's history, as well as its current performance, in an easily understood form.

Further research opportunities in this area are available. As the new SALTS modification and CitiDirect programs transmit and reconcile invoices, the question remains if the potential has been met. Do these improved procedures further decrease reconciliation times, and what additional improvements can be made to the process beyond these improvements? Additionally, the results in Chapter III specifically address only CNSL and CNSP. Analyzing Navy and Marine Corps shore activities or other fleet units can help verify that the findings in Chapter III apply to all activities.

APPENDIX A. DEFINITIONS

ActRecDate – The date that the ship annotates on the invoice indicating receipt.

ActRecOPLOCRec – The total time (in days) from account received date until received at the paying activity

Agency Program Coordinator (APC) – An individual designated as the point of contact for purchase card issues and who has overall responsibility for the purchase card program within his/her organization.

Approving Official (AO) – An individual who oversees a number of cardholders. The AO is responsible for reviewing his/her cardholder's monthly statements and verifying that all transactions are for necessary materials and services. The AO is usually the cardholder's immediate supervisor.

Cardholder – An individual issued a card by an organization. The purchase card bears the individual's name and can be used to pay for official purchases of government materials and services.

Designated Billing Office – The office designated to make payments against the official certified invoice. For navy activities, this is DFAS or a subordinate activity of DFAS. The author refers to this as the paying activity. DFAS refers to the subordinate activities as OPLOCs. The author will refer to OPLOCS as the paying activity.

IntAmt – Interest paid divided by the amount of the invoice

InvActRec – The total time (in days) from invoice date until account received date

InvDate – The date that the invoice is generated by the issuing bank

InvPay – The total time (in days) from invoice date until pay date

Micro-purchases – Supplies or services (other than construction) valued at less than $2,500.00

OPLOCRecPay – The total time (in days) from receipt at the paying activity unitl the invoice is paid.

PayDate – The date that the paying activity pays the invoice

Standard Automated Logistics Toolset (SALTS) – An electronic message service maintained by the U.S. Navy that permits electronic transmission of messages or files to

other activities. SALTS transmits messages via INMARSAT satellite, DoD networks, or telephone land lines. The data is placed in an electronic "post office box" and automatically downloaded to the activity the next time they call in to SALTS. [Ref. 11]

APPENDIX B. INTEREST PAYMENT SUPPORTING INFORMATION

Claimant	June	July	August	Total
CINCLANTFLT	$18,494.17	$11,848.01	$26,894.30	$57,236.48
NAVSEA	$13,758.54	$11,941.85	$17,532.40	$43,232.79
CINCPACFLT	$21,582.19	$10,388.59	$9,644.62	$41,615.40
BUMED	$3,719.40	$10,373.91	$4,797.54	$18,890.85
NAVAIR	$3,828.88	$3,707.26	$8,947.89	$16,484.03
COMNAVRESFOR	$4,339.14	$4,883.15	$4,093.35	$13,315.64
Not Identified	$4,901.98	$2,315.27	$4,355.23	$11,572.48
CNO	$2,437.87	$1,764.91	$4,843.77	$9,046.55
NAVSUP	$1,793.12	$1,738.42	$4,845.29	$8,376.83
COMNAVPERS	$1,019.60	$2,044.14	$3,736.61	$6,800.35
SPECWAR	$3,525.30	$416.77	$2,592.26	$6,534.33
UNSECNAV	$451.80	$1,379.45	$2,174.80	$4,006.05
CNET	$1,893.97	$1,600.11	$0.00	$3,494.08
NAVFAC	$1,188.64	$49.49	$2,092.51	$3,330.64
NAVMETOCCOM	$40.93	$2,256.56	$189.05	$2,486.54
NCTC	$347.98	$1,050.60	$876.08	$2,274.66
NAVSECGRP	$215.17	$768.75	$354.49	$1,338.41
HQUSMC	$76.22	$907.75	$60.06	$1,044.03
SSP	$364.91	$6.13	$609.51	$980.55
ONI	$677.27	$82.85	$98.13	$858.25
CNR	$93.03	$328.97	$159.89	$581.89
SPAWAR	$7.08	$0.00	$0.00	$7.08
NAVFOREUR	$0.00	$6.52	$0.00	$6.52
Total	**$84,757.19**	**$69,859.46**	**$98,897.78**	**$253,514.43**

Table 8 Interest paid fourth quarter FY 1999 due to activity errors categorized by major claimant. [Ref. 3]

OPLOC	June	July	August	Total
Charleston	$3,915.86	$3,062.09	$1,408.04	$8,385.99
Honolulu	$76.97	$317.73	$0.00	$394.70
Norfolk	$1,132.29	$18.89	$0.00	$1,151.18
Pensacola	$4,160.16	$8,094.24	$1,125.35	$13,379.75
San Diego	$3.95	$5,125.60	$42.02	$5,171.57
Washington	$83.96	$161.61	$2,856.12	$3,101.69
Total	**$9,373.19**	**$16,780.16**	**$5,431.53**	**$31,584.88**

Table 9 Interest paid fourth quarter FY 1999 due to OPLOC errors categorized by OPLOC location. [Ref. 3]

Major Claimants:	CitiBank as of 6/16/99	CitiBank as of 7/8/99	CitiBank as of 8/19/99	*CitiBank as of 9/9/99	*CitiBank as of 10/7/99
HQUSMC	394,604.82	723,294.13	1,763,121.60	2,648,984.53	1,893,492.16
CINCPACFLT	98,119.96	282,220.97	469,551.62	991,862.28	1,110,687.64
NAVSEA	243,809.89	277,618.51	477,361.63	664,252.55	505,310.65
CINCLANTFLT	279,623.69	452,410.92	518,152.13	609,101.48	415,230.52
CNO	58,945.14	67,825.62	92,236.69	154,810.95	278,818.87
COMNAVRESFOR	39,941.29	60,973.66	48,171.27	147,183.58	236,915.43
NAVPERSCOM	39,204.20	112,381.14	22,009.50	82,898.35	215,806.88
NAVFAC	25,779.78	109,459.60	140,730.06	152,704.75	209,506.78
BUMED	881.24	49,514.71	39,899.98	104,314.36	198,504.82
NAVSYSMGTACT	555.88	185,923.47	24,839.87	131,197.31	175,742.65
NAVSUP	25,193.32	215,805.29	284,585.50	142,225.20	61,024.90
NAVAIR	106,156.78	106,234.64	92,346.29	147,777.06	54,537.91
CNR	0.00	0.00	1,227.36	21,018.27	46,305.59
CINCUSNAVEUR	283.21	7,821.32	58,984.75	97,425.90	40,926.69
NAVSECGRP	0.00	0.00	52.21	2,264.48	38,068.12
UNSECNAV	54.58	51,546.38	7,017.21	8,675.06	26,673.82
CNET	530.88	7,499.51	405.98	1,087.09	5,844.41
MSC	0.00	0.00	1,171.00	525.24	2,077.72
NAVCOMTEL	0.00	0.00	60.96	4,730.83	0.00
NAVMETOCCOM	2,694.55	10,523.86	0.00	2,354.63	0.00
ONI	0.00	20.93	0.00	0.00	0.00
DIRSSP	0.00	0.00	100.00	200.00	0.00
SPAWAR	0.00	0.00	0.00	0.00	0.00
NAVSPECWARCOM	0.00	0.00	0.00	0.00	0.00
TOTALS	**1,316,379.21**	**2,721,074.66**	**4,042,025.61**	**6,115,593.90**	**5,515,475.56**

Table 10 Balance due for invoices outstanding greater than 60 days during fourth quarter FY 1999. [Ref. 3]

APPENDIX C. MEAN DURATION AND STANDARD ERROR ESTIMATES

When generating the point estimates for mean and standard deviation for each time-measured variable, each ship's data is weighted equally. Since some ships have multiple invoices each month, a straight mean or deviation across data points would weight that ship's numbers more heavily. As a result, all ships' monthly data are averaged to obtain one monthly figure for each ship; those monthly figures are used in the calculations.

		InvPay		InvActRec	
Inv Cat	Rank	CNSL	CNSP	CNSL	CNSP
1	1	65.1 (14.3)	55.0 (13.3)	20.7 (9.6)	24.0 (13.0)
	2	103.2 (38.9)	54.0 (16.5)	35.8 (22.8)	17.0 (9.5)
	3	87.8 (39.4)	59.4 (15.6)	15.9 (2.3)	21.6 (7.5)
	avg	**85.4 (20.3)**	**56.1 (12.7)**	**24.1 (11.3)**	**20.9 (7.7)**
2	1	69.9 (23.8)	57.0 (11.0)	20.6 (10.7)	18.0 (3.5)
	2	94.4 (34.5)	80.1 (51.3)	11.9 (14.8)	19.4 (3.5)
	3	122.3 (40.7)	51.5 (4.7)	46.5 (18.6)	19.4 (6.4)
	avg	**95.5 (28.2)**	**62.9 (19.2)**	**26.3 (13.4)**	**18.9 (5.8)**
3	1	43.1 (7.35)	35.0 (10.0)	24.6 (12.3)	21.0 (13.8)
	2	77.2 (26.8)	36.2 (5.8)	16.9 (6.2)	18.0 (2.8)
	3	69.3 (25.9)	53.8 (19.3)	29.7 (17.9)	18.3 (3.3)
	avg	**63.2 (12.8)**	**41.7 (10.1)**	**23.7 (10.5)**	**19.1 (4.9)**
Total	**avg**	**81.4 (24.4)**	**53.6 (13.0)**	**24.7 (10.0)**	**19.6 (6.2)**

Table 11 Point Estimates for Mean and Standard Deviation for InvPay and InvActRec Categorized by Invoice.

		ActRecOPLOCRec		OPLOCRecPay	
Inv Cat	Rank	CNSL	CNSP	CNSL	CNSP
1	1	29.6 (22.5)	13.0 (.7)	14.7 (11.8)	19.0 (4.3)
	2	51.4 (49.5)	22.0 (14.5)	15.9 (8.8)	15.0 (6.3)
	3	44.8 (25.6)	18.5 (23.4)	27.1 (21.9)	19.3 (6.7)
	avg	**41.9 (28.0)**	**17.8 (10.8)**	**19.2 (12.9)**	**17.8 (4.9)**
2	1	32.7 (19.4)	29.0 (17.0)	16.7 (14.2)	11.0 5.3)
	2	59.2 (33.9)	48.1 (41.3)	23.4 (6.0)	12.7 (3.4)
	3	61.9 (47.3)	19.9 (9.4)	13.9 (5.6)	14.2 (4.2)
	avg	**51.3 (29.7)**	**32.3 (19.3)**	**18.0 (8.1)**	**12.6 (3.7)**
3	1	12.0 (5.3)	6.0 (2.8)	6.4 (3.7)	8.0 (3.8)
	2	21.3 (16.8)	6.0 (2.7)	30.1 (34.9)	10.3 (2.3)
	3	22.1 (12.7)	27.3 (22.1)	57.7 (56.2)	8.3 (.9)
	avg	**18.5 (9.7)**	**13.1 (7.9)**	**31.4 (26.8)**	**8.9 (2.0)**
Total	**avg**	**37.2 (20.7)**	**21.1 (12.2)**	**22.9 (12.5)**	**13.1 (3.5)**

Table 12 Point Estimates for Mean and Standard Deviation for ActRecOPLOCRec and OPLOCRecPay Categorized by Invoice.

		InvPay		InvActRec	
Rank	Inv Cat	CNSL	CNSP	CNSL	CNSP
1	1	65.1 (14.3)	55.0 (13.3)	20.7 (9.6)	24.0 (13.0)
	2	69.9 (23.8)	57.0 (11.0)	20.6 (10.7)	18.0 (3.5)
	3	43.1 (7.4)	35.0 (10.0)	24.6 (12.3)	21.0 (13.8)
	avg	**59.4 (16.3)**	**49.0 (9.5)**	**22.0 (9.2)**	**21.0 (8.3)**
2	1	103.2 (38.9)	54.0 (16.5)	35.8 (22.8)	17.0 (9.5)
	2	94.4 (34.5)	80.1 (51.3)	11.9 (14.8)	19.4 (3.5)
	3	77.2 (26.8)	36.2 (5.8)	16.9 (6.2)	18.0 (2.8)
	avg	**91.6 (32.9)**	**56.8 (21.0)**	**21.5 (13.0)**	**18.1 (6.4)**
3	1	87.8 (39.4)	59.4 (15.6)	15.9 (2.3)	21.6 (7.5)
	2	122.3 (40.7)	51.5 (4.7)	46.5 (18.6)	19.4 (6.4)
	3	69.3 (25.9)	53.8 (19.3)	29.7 (17.9)	18.3 (3.3)
	avg	**93.1 (34.6)**	**54.9 (11.0)**	**30.7 (16.3)**	**19.8 (4.7)**
Total	**avg**	**81.4 (22.0)**	**53.6 (13.4)**	**24.7 (12.1)**	**19.6 (6.2)**

Table 13 Point Estimates for Mean and Standard Deviation for InvPay and InvActRec Categorized by Rank.

		ActRecOPLOCRec		OPLOCRecPay	
Rank	Inv Cat	SURFLANT	SURFPAC	SURFLANT	SURFPAC
1	1	29.6 (22.5)	13.0 (0.7)	14.7 (11.8)	19.0 (4.3)
	2	32.7 (19.4)	29.0 (17.0)	16.7 (14.2)	11.0 (5.3)
	3	12.0 (5.3)	6.0 (2.8)	6.4 (3.7)	8.0 (3.8)
	avg	**24.8 (14.9)**	**16.0 (6.2)**	**12.6 (9.3)**	**12.7 (3.8)**
2	1	51.4 (49.5)	22.0 (14.5)	15.9 (8.8)	15.0 (6.3)
	2	59.2 (33.9)	48.1 (41.3)	23.4 (6.0)	12.7 (3.4)
	3	21.3 (16.8)	6.0 (2.7)	30.1 (34.9)	10.3 (2.3)
	avg	**44.0 (31.9)**	**25.4 (16.7)**	**23.1 (16.2)**	**12.7 (3.4)**
3	1	44.8 (25.6)	18.5 (23.4)	27.1 (21.9)	19.3 (6.7)
	2	61.9 (47.3)	19.9 (9.4)	13.9 (5.6)	14.2 (4.2)
	3	22.1 (12.7)	27.3 (22.1)	57.7 (56.2)	8.3 (0.9)
	avg	**42.9 (37.3)**	**21.9 (15.1)**	**32.9 (21.9)**	**13.9 (3.1)**
Total	**avg**	**37.2 (23.3)**	**21.1 (12.2)**	**22.9 (14.9)**	**13.1 (3.3)**

Table 14 Point Estimates for Mean and Standard Deviation for ActRecOPLOCRec and OPLOCRecPay Categorized by Rank.

APPENDIX D. MINITAB

The author uses Minitab to generate the control charts and descriptive statistics because it is easy to use and requires minimal statistical knowledge.

Minitab costs approximately $550.00 for a single copy, with site licenses costing less per copy. It is an easily understood, windows-based program that produces graphs and other tools used to manage processes. This is a benefit considering the limited statistical exposure characterizing most potential users. The SPC tools utilized are designed primarily for manufacturing processes, but the same techniques can be employed for non-manufacturing processes, like the reconciliation process that is addressed in this thesis. The needed data can be accessed by running queries on the DFAS database.

The DFAS database is set up to extract queries based by UIC in an Excel format (which can be directly imported into Minitab). Any number of UICs and any date range can be selected for review. Multiple UICs can be grouped to form an aggregate set of graphs, or UICs can be analyzed singly. As noted in Chapter II, the data extracted should be reviewed prior to analysis; duplicate records were found in the database. This review can be conducted in Excel or Mintab, depending on the user's preference.

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